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ELECTRICAL TOWING ON THE NEW YORK STATE CANALS.

It is proposed to introduce electrical towing on the New York State canals. Aside from all question of the advisability of retaining the canals as a means of transportation, it has been shown abroad that electrical towing of barges is not only practical but economical. The speed can be as great as the safety of the canal will permit, and there is less wash caused by this method of propulsion than by the use of self-propelling boats. There are several ways in which electrical towing may be applied. In one an electrically operated traction engine runs upon the towpath, draws its supply from overhead lines. A light railway may be laid down along the path for a suitable motor vehicle to travel upon. There are several systems using this method, some of which have but a single rail. The elevated system proposed for the New York canals may be applied several ways. In that which has found the greatest favor abroad, the towing motor is suspended from and travels along an overhead cable. The problem of supplying power to the towing motor is not different from that presented by light country trolley, although the length of the canals will make high potential distribution necessary.

THE EFFECT OF WIRELESS RADIATIONS ON AERIAL CONDUCTOR SYSTEMS.

On another page of this issue will be found a discussion by Mr. Joseph B. Baker upon the effect of wireless radiation upon aerial conductor systems. Mr. Baker emphasizes his remarks by a brief sketch of the troubles and contentions which arose when the electric railway was first introduced on a practical scale. As will be recalled, at that time the telephone systems were using the earth return, and when the railways began to make use of the same medium, trouble arose. The fight was carried on for some time, and, as it could not be shown that the telephone companies had an exclusive right to the use of the earth as a conductor, they were forced to abandon it and use either a common return or metallic circuit in order to give their customers satisfactory service. But at the same time, the railway companies soon found out that the earth itself was valueless as a return—that it had an appreciable resistance and that the earth plates which they were accustomed to bury and connect with the track in the earlier roads, had no value whatever.

Electrolytic Troubles.

Later on, we had the fight between the railway companies and those companies which bury metallic pipes or conducting systems in the ground. It was found that electrolytic action was started which resulted in more or less destruction of the pipes or metallic systems. The railway companies themselves soon realized that it was not economical to depend upon the earth as a conductor, and that proper construction called for an ample outlay of copper for the return circuit.

Possibility of Wireless Messages Affecting Other Distributing Systems.

In these instances the trouble between the two contestants arose from the attempted simultaneous use of the common circuit of the earth. In wireless telegraphy, the energy is radiated through space, and anything lying in this space may be affected by these radiations. The effect, of course, will depend upon the amount of energy sent out from the sending station, the proximity of this to the affected lines and the electrical constants of both the sending system and that affected by the disturbance and the position of the latter. Just what effects ought to be expected it is impossible to say at this time, but if newspaper reports are to be credited they will be quite appreciable upon lines situated near powerful sending stations. What regulations will be necessary can not as yet be foretold. If the sending station for some wireless telegraph system is going to put out of service all telephone lines anywhere near it, there is bound to be trouble. It does not seem possible to force the telephone and telegraph companies to bury all their lines, and, in fact, this would be impossible at this time. The problem involves more than the mere insulating and laying in trenches of conducting cables, for these cables have very different constants from the aerial lines now in general use.

Will Wireless Sending Stations Affect Tall Buildings.

What effect also will these sending stations have upon the metal pipes and framework of our modern high buildings? We have here vertical conductors of a height approximating those of the usual sending wire, and should the electrical constants of this pipe give it a period of oscillation approximating that impressed upon it from the sending station, will not this pipe become "charged" and who can tell with what effects? The probable effect of a powerful wireless telegraph sending station within a large city certainly seems to be a question deserving of the most careful and thorough consideration.

ENGINEERING DATA.

On another page of this issue will be found a communication from Mr. Joseph E. Lockwood, in which the writer makes a plea for more thoroughness and completeness in compiling engineering data. The particular case in point here was brought out by an attempt to compare the results of tests of a number of power stations. Reports of station performance usually give the output in kilowatt-hours and the corresponding coal consumption, but the water evaporated in the boilers is not always measured. This was found by Mr. Lockwood to be the condition of the reports which he wished to compare.

Data for Water Evaporated Essential in Reports.

Now, it hardly need be said that the quality of coal varies so greatly that no figures based simply upon the consumption of coal per kilowatt-hour can be compared intelligently, nor is the case helped much by giving the price of coal, because this figure varies greatly, depending upon the locality. The physical properties of water, however, are accurately known, and when the consumption of water per kilowatt-hour is given in the report of a test, we have a definite point to start from in making comparisons. It is not difficult to secure the figures for the consumption of water in making a test, and the slight amount of additional trouble taken here may mean all the difference between a valuable and a worthless piece of work. The only object in making a test of a power station is to secure data by which the performance of the station may be compared with that of others, and information thereby obtained which may lead to improvements and economies. There, therefore, seems to be little excuse for making a test unless it is to be complete, or for publishing a report in which full data are not given.

Completeness Essential in All Data.

But this is by no means the only instance in which improvement is necessary. It is unfortunately true that a great deal of the technical literature published to-day is worthless because it is incomplete. This is true, not only in reporting tests, but in describing machinery and installations. Of what value is it to a designer to know the number of conductors upon a generator armature and its peripheral speed if no information is given about the magnetic circuit? Of course, this incompleteness is not true of all cases, but it is probably not generally realized how much of technical literature is valueless. At this time an effort is being made to compile data upon electrical engineering practice, and all should be glad to assist in this praiseworthy undertaking. It should, however, be borne in mind that this data must be complete if it is to be useful, and therefore no pains should be spared to give in each case all valuable information. It is always easy to eliminate superfluous statements, but it is seldom possible to supply an omission.

SUPPRESSION OF NOISE IN THE CITIES.

An order was issued recently by the New York Central Railroad Company instructing officers and employés at its terminal to avoid all unnecessary noises. Train hands will not be permitted to call signals from one to the other, but must rely entirely upon the hand or a lantern. Train inspectors must avoid unnecessary noises in examining running gear. Locomotives moving through the train yard must not ring the bell continuously, but simply give a few taps before starting, to warn persons in the vicinity. The blowing-off of safety valves and air from the air-hose will not be permitted. This is certainly a very commendable move on the part of the railroad company and will add greatly to the comfort of its patrons. It perhaps may be wondered why this action was not taken before.

Another Instance.

It is a fact that there is a great deal of unnecessary noise caused by railroads, electric as well as steam. Some of this could be avoided without any inconvenience to the railway companies. We are aware of one instance where the Pennsylvania Railroad Company, by request of its patrons who live along one of its suburban lines, abandoned the whistling signal given by trains approaching stations. The stations upon this line are not far apart and train service is frequent, so that there was almost an incessant tooting of locomotives throughout the day and a large part of the night. This practice was abandoned without any inconvenience to the railway company, but it was a decided benefit to residents in the neighborhood of the road. It would seem that this signal for stations is a relic of the past, and of little use in thickly settled districts. It is no aid to the passengers and superfluous to the station hands, who are already aware of the approach of the train before the signal is given.

Other Sources of Noise.

But, as suggested above, the steam railroads are not the only ones which cause a great deal of unnecessary noise. There is much room for improvement in this respect in our street railway operation. The incessant ringing of gongs is not necessary and besides being very irritating to residents along the line, pedestrians become so hardened to the sound that its value as a danger signal is greatly impaired. Of course, there is a good deal of noise caused by motor-driven cars which is difficult if not impracticable to avoid, but there is as well a great deal which could be diminished if not done away with entirely. Recently this matter was taken up in Berlin, Germany, and a commission appointed to look into the means for lessening the noise caused by the elevated railway. A similar commission in any of our large cities might accomplish much without interfering with the operation of the road. As a matter of fact, there is entirely too much noise in all our large cities. It is not the noisiest man or vehicle which accomplishes the most. A more general use of automobiles will improve matters considerably by banishing the horse and because these new vehicles are generally equipped with rubber tires. Perhaps it is too much to hope for a considerable improvement in this matter in our bustling towns, but it seems worth while at least to call attention to it.

THE COOPER HEWITT INVENTIONS.

It is seldom that one worker in one line of electrical investigation is able to announce discoveries and developments of such importance as those of Mr. Peter Cooper Hewitt, which have been described recently.

The Mercury Vapor Lamp.

Mr. Peter Hewitt has been at work upon his mercury vapor lamp for some

years. This lamp is undoubtedly the most efficient light existing to-day, and it has a number of features which add greatly to its value. In addition to its high efficiency its life should be long. It can be constructed in any desirable shape and in contrast with the methods of lighting now in use, it throws out light from a large surface and not from a point. This feature will be great in value in decorative lighting, giving us, as it does, lines of light instead of dots. What seems to be a serious objection to this lamp at this time is its color. The absence of red rays produces unusual, and, from our present point of view, undesirable effects, as we have been accustomed to thinking orange or yellow light desirable for inside illumination. However, those who have had experience say that it is very easy to work by this light, and that the eyes are much less fatigued than when other artificial illuminants are employed. Much work has been done to improve the quality of the light given by this lamp, and it is to be hoped that practical results will be secured, for its application in its present form will meet with much opposition.

The Mercury Vapor Converter.

The study of the Cooper Hewitt lamp has resulted in the discovery of certain physical phenomena which have been put to useful application. The vapor converter when supplied with an alternating current delivers a direct current and does this with a high efficiency, and without the aid of any moving parts. In this device the so-called negative electrode resistance is made use of to prevent a flow of current in one direction through the device. This apparatus can be built in a comparatively large size, and as two more can be operated in parallel, there would seem to be a wide field for its application.

The Mercury Vapor Interrupter.

In another device the mercury vapor interrupter, the same phenoména of high negative electrode resistance are made use of in charging a condenser, and the practical disappearance of this resistance, when certain high potential has been reached, enables the condenser to be discharged at a high speed and with but a small loss of energy. The importance of this device in wireless telegraphy has been discussed recently so that it is not necessary to say any more about it at this time.

Encouragement to Other Workers.

We thus have three valuable inventions useful in three different lines of applications resulting from the study of one subject, two being by-products, as it were, of the endeavor to secure a lamp of high efficiency. And it seems probable that these are not all. Mr. Hewitt is certainly deserving of high praise for his remarkable work, and his success should encourage others who have the means and ability to take up seriously some line of original research work. For those who have special ability, the Carnegie Institute stands ready to lend financial aid.

ELECTRICAL MINING NOTES—II.

BY SIDNEY F. WALKER.

HAULING BY ELECTRICITY.

In all modern collieries in this country there are two main roads, sometimes more, running out from the shaft bottoms to the boundary of the "royalty"—the boundary of the area over which the colliery company has the right to take the coal. The two roads are primarily air roads, one takes the air from the surface to the workings, and the other brings the vitiated air from the workings to the other shaft. The shaft which supplies the fresh air is called the downcast, and that which conveys the vitiated air away is called the upcast. The latter is covered in to prevent the back pressure of the atmosphere from interfering with the ventilating air current. The road which conveys the air to the workings is called the intake, and the other the return. It is very rare, even in gaseous mines, to find gas—fire damp—in the intake, though in some very bad cases the gas comes away so rapidly on certain occasions as to overpower the air current, and it is then found in the intake. It is usually, therefore, perfectly safe to use electric motors and every kind of electrical apparatus in the intake airway; and mining engineers always endeavor, as far as possible, to keep the motors to the intake, or close to it. The return airway, however, is always dangerous in gaseous mines, and all cables, starting resistances, etc., should be kept away from it. Naked lights are usually employed at the bottom of the upcast shaft and for a considerable distance along the intake airway. In all gaseous mines, however, there is a limiting distance where a lamp station is fixed, and where the colliers come to have their lamps opened and relighted if they have gone out, a thing which happens somewhat frequently with the oil lamps in use.

The main airways are also usually the main haulage roads. From the main roads smaller roads branch off at intervals, leading to the working faces, or rather to the roads from which the working faces spring. The positions where the coal is being hewn is called the working face. It is the frequent practice now, in the collieries of the United Kingdom, to work the main haulage roads by what is known as the endless rope system. A wire rope, commencing at a point near the shaft bottom, where the driving apparatus is fixed, runs out the full length of the road, is coiled around a tightening pulley at the end, and is brought back to the point from which it started, where the two ends are connected together. Motion is given to the rope by the driving apparatus in such a manner that one-half of the rope travels away from the shaft and the other half travels toward the shaft. Hence, any coal wagon which is hitched to the half of the rope which is traveling toward the shaft is brought out from the workings, and any which is hitched to the other half of the rope is carried into the workings. The empty trams, which are brought from the surface after their coal has been tipped out of them, are hitched on to what is called the empty rope, and the trams which have been filled with coal are hitched on to the other half, the full rope, as it is termed. A common method of imparting motion to the rope is by coiling it around two pulleys, one in front of the other, the rope passing three times around each. This gives sufficient grip between the pulley and the rope to move the latter, with its load, when the pulley is driven from any source of power. What are termed clip pulleys have been used, but are now going out. The trams are usually hitched to the rope singly, but, in some cases, trains of trams are made up and the front tram is hitched to the rope.

For the small roads, which act as feeders to the main haulage and which are called secondary haulage roads, two methods are in use, which are known as the main and tail, and endless rope. The endless rope is exactly similar to that used with the main haulage, and it sometimes takes its power from the main haulage rope, the main haulage rope working a pulley to which the secondary system is attached. The loaded trams are hitched

on to the full rope as near the working coal face as convenient, and the empty trams are run back to the same point. When the full trams arrive at the junction with the main haulage road, they are unhitched, pushed on to the main road and hitched on to the main haulage rope. With proper calculation, on this arrangement, it will be seen coal is constantly pouring to the shaft bottom and empty trams are constantly pouring back to the working faces. Some mining engineers, however, prefer the main and tail system for secondary haulage. With this system there are two ropes, a main rope which hauls the coal from the working face to the junction with the main road, and the tail rope which follows behind the train of trams, and is afterward used to draw the empty trams back to the workings. There are two drums clutched separately to one shaft, on which the two ropes are coiled up when not in use. Each drum can be turned in either direction, so as to wind up the rope it carries or allow it to run off. Several trams are connected together to form a train, the main rope being connected to the front of the train and the tail rope, which has been run out to the end of the road and taken round a pulley there, connected to the rear of the last tram. Then the drum carrying the main rope is revolved in the direction for winding up, the other drum at the same time being allowed to run freely. The main rope is coiled up on its drum, bringing the trams along with it, and the tail rope is run out, till when the journey, as it is called, of trams arrives at the junction the main rope is all coiled up on its drum and the tail rope has run out to its full length, double the length of the road. The full trams having been disposed of, a train of empty trams is made up, connected between the two ropes, in the same way as the full trams were, the drum carrying the tail rope is revolved to wind up, drawing the empty cars out to the working face, and the main rope is allowed to run out. When the empty trams arrive at the collecting place near the working face, the main rope is ready to perform its office of pulling the next journey of full trams out to the main road again. The reason why some mining engineers prefer main and tail rope to the endless rope system is because the endless rope system requires the provision and maintenance of roads of double the width of those required with main and tail, and in many mines this is a very serious matter. Room for only one set of trams abreast is required with main and tail for two with endless.

Mine roads are subject to so many adverse forces. The pressure of the strata above, the expansions and contractions caused by difference of temperature and other cases, lead to partial closing up of the roads. The roof tends to come down, the floor to come up and the sides to come in. And these tendencies are all greater the larger the sectional area of the road.

So strong is the feeling in favor of main and tail, in consequence of the above, that the mine haulage of many collieries is still worked on this system. The leading mining engineers, however, are trending toward the endless rope system wherever it is practicable, as, in addition to being a cheaper method of working, the fact of having larger roads gives better ventilation.

The problem involved in providing a certain air current in a mine is very similar to that involved in providing a certain electric current in an electric circuit. The longer the roads through which the air current has to pass the greater is the resistance offered to its passage, and the larger the sectional area of the road the less is the resistance, other things being the same. The work done in transporting any given quantity of coal over a certain distance is the same whether the haulage is on the main and tail or endless rope system, but a larger engine is required for driving the main and tail system, to pull out a given quantity of coal in a given time, and as the engine is standing for some time between the journeys, the fuel cost is larger, where the haulage is worked by steam engines. This does not apply to working by electric motors. On the other hand, the working with endless rope, whether with steam or electric motors, is more even, and the repairs less, than with main and tail.

For driving the haulage drums and pulleys with steam, or compressed air, one or two engine cylinders, usually two, are carried on the same bed-plate as the haulage drums or pulleys, and are geared to the drum shaft by spur-gearing. In some cases there will be two or more ropes working from one engine house, and in that case the engine drives one shaft, and the different drums or pulleys are connected to the driving shaft by friction clutches, which enable any drum to be thrown into gear or out at will. For electric driving, it is only necessary to fit the motor in any convenient position and connect it mechanically to the driving shaft by spur or worm-gearing. Spur-gearing has been used almost universally, but worm-gearing has many favorites, it is so compact. The great objection to worm-gearing is the difficulty experienced in getting it efficient. With the double and treble worm, however, and with special machinery for cutting the worms and the wheels which gear into them, this trouble is gradually disappearing. Continuous-current and polyphase-current motors are in use for driving both main and tail and endless rope haulage, shunt-wound motors being the favorite with continuous-current working. There is the same trouble with starting resistances, and starting switches with electrically driven haulage, as with electrically driven pumps; but as the haulage engine houses are better found and better kept, it is much easier to have substantial apparatus, and those who have been responsible for putting down electrical haulage plants are alive to the matter. It should be mentioned that there are many more endless rope haulage plants run by electric motors than main and tail. The reason is, mining engineers have been rather doubtful about trusting electric motors with main and tail haulage on account of the heavy strains at starting the journey of trams fully loaded. Improved construction, however, is putting this matter right also. It is not difficult to arrange a proper switchboard in the haulage engine house, giving full warning to the attendant of anything wrong.

WINDING BY ELECTRICITY.

This has been very little adopted in this country, as mining engineers are slow to believe that it can possibly be economical. It is in use on the Continent to a somewhat large extent, however. The electrical winding plants in operation in this country are at present small. Winding, or, as it is called in America, hoisting, a much more suitable term, consists in lifting the coal in its trams from the shaft-bottom to the top. The term winding arises from the fact that the operation is performed by winding a rope on a drum. There is a large drum fixed a little way from the pit mouth large enough to carry one rope, and it is usually driven by a pair of steam engines, one on each side of the drum shaft, to which the connecting rods of the engines are attached. There are always two wire ropes employed in winding, and two cages. The cages are the platforms on to which the coal trams are run, to be hoisted out of the mine. The cages are often double, and sometimes treble-decked. That is to say, they may have one platform for the coal trams, two platforms, or three; and each platform may be arranged to carry one, two, three or four trams. Four trams in the collieries where the output is large is very common, two trams being carried on each of the two platforms. The cage is slung by

chains which are attached to the end of a wire rope, the other end of which is secured to the winding drum. As one cage descends the other ascends, so that there is always the same length of wire rope coiled on the drum; one rope paying out as the cage descends, while the other rope winds up in the same proportion. But the work done throughout the wind is by no means the same. It is very heavy at the commencement, when the cage with its full trams has to be lifted off the bottom of the shaft, and it is sometimes heavy during a large portion of the wind if the speed of winding is great; but in all cases, especially where the mines are deep, steam is shut off entirely for a large part of the later portion of the wind, the full cage being raised by the momentum of the descending cage. Steam is also partially cut off at an earlier portion of the wind. Also during the intervals between the winds the engines are standing and cooling, so that there is a considerable loss from cylinder and pipe condensation. From some tests which were taken a few years ago it appeared that the coal consumed in actual winding was at the rate of eleven pounds per indicated horse-power, and this did not take into account the condensation due to heating up the engine after stoppages of even short duration. After the coal has been drawn out of the mine, for the day's work, the winding engines have still to be ready for winding men and stores when required. Pit wood, stone for walls, etc., have to be sent down from time to time, and night men and officials have to go down and be drawn up from time to time. The condensation during these long waits, and on starting, must be heavy. In the writer's opinion, the coal consumption could be reduced to three pounds per indicated horse-power, after allowing for all losses of conversion, if electric winding were adopted. Some collieries are arranging to take current from the great electric power stations which are being laid down, and one colliery in Lancashire is taking current from an electric tramway service which is close to it, the colliery being on the outskirts of one of the Lancashire towns. Winding is done by electric motors in this colliery. A somewhat serious affair took place at the colliery, however, a short time since. The supply of the electric tramway service failed for several hours. A feeder had parted, and the colliers could not be drawn out of the pit, much to their consternation. As before indicated, electric winding is being used in the county of Durham for winding up what are called staple pits, that is, small pits leading from one seam to the other at some distance from the main shafts.

To adopt the existing winding arrangements for electric winding, it is only necessary to remove the steam cylinders and connect the electric motors, two should be employed to the drum shafts by spur-gearing or worm-gearing, as preferred. Objection is taken to the usual method of starting electric motors, by the addition of resistance to the circuit for winding, on the ground that the loss in heating the resistance will be considerable in winding where stops and starts take place so frequently, every two minutes or so. Methods are being worked out —the writer has heard of two at least— for getting over this difficulty. A somewhat similar difficulty exists with printing machinery, which has to be driven very slowly at first, and has to be controlled to the speed at which it is required to turn the paper out. But the difficulty has been overcome in these cases, and will doubtless be overcome in the case of winding.

DRIVING FANS BY ELECTRICITY.

It can not be pretended that it is more economical to drive the main fan at a colliery by an electric motor, except in those cases where the whole of the colliery is run from an electric supply service. But there are many cases where it is useful to place subsidiary fans in the workings, to direct currents of air into particular portions of the working face, and in those cases the electric motor is about the most convenient method that can be adopted. One difficulty arises in this connection, *viz.*, the matter of the gas. In gaseous mines it is not wise to place the motor which is driving a subsidiary fan in the return airway, but this difficulty can usually be got over by placing the fan in whatever position it is required, and fixing the motor in the intake airway, transmitting the power from the motor to the fan by means of ropes. As the distances between the intake and return are often not great this can easily be done, and fans are very much used; electrically driven in coal mines, sometimes directly driven, and sometimes driven in the manner suggested. There are also cases where a fan is required to be driven at a distance from the main fan, on the surface, and electricity then provides the most convenient method of transmitting the necessary power.

THE DANGERS OF ELECTRICITY IN COAL MINES.

In the writer's opinion, these are not at the motors, except in special cases, such as where the commutator becomes so hot that it is at the ignition point of the gas. The real danger is in the cables, and the possibility of a spark passing, sometimes forming into an arc between the cables when they are damaged by falls, etc. More than one case has occurred of collieries having been set on fire by this means. The danger would be minimized by spending more on the cables, but there is always a tendency to cut this item down, both when the cables are first laid and when any renewal takes place. The danger to life arises principally from the power service making "earth." In some collieries it is the practice to deliberately put one side of the circuit to "earth" by using concentric cable, making the outer, which is uninsulated, the return. Several fatal accidents have occurred from this with the regular 500-volt service.

OTHER USES OF ELECTRICITY.

There are now a number of machines about a colliery of any size which may conveniently be driven by electric motors, and there is a great deal done in British collieries at the present day. They are used for running the coal-washing machines, which are now employed at so many collieries, for cranes, for jiggling screens, and many other machines.

THE PRESSURE IN USE IN BRITISH COLLIERIES.

This is nearly always 500 volts, or thereabouts. In some cases engineers have designed their generators for 450 volts, at convenient speeds, in others, for 550 volts. In a few cases, 200, 400 and 600 volts have been employed. The continued extension of the coal mines, however, and the large powers required at a distance from the shaft bottoms, together with the increasing depth of the coal mines, is leading to higher and higher pressures. In a case in which the writer was called in to advise recently, he found it absolutely necessary to provide for a pressure of 2,000 volts to be taken into the mine for some distance, the cables to be in the intake airway, and to be transformed down to 100 volts for the haulage service. There were a number of secondary haulage plants to be worked, aggregating 1,000 horse-power at a mile from the shaft.

Abrasive materials are divided into three classes—those which occur in rock formations and are cut or manufactured into the form desired, still retaining their original structure, as grindstones, whetstones, etc.; those which occur as constituents of rocks or veins, and have to be mechanically separated from their gangue, as garnet, corundum and emery; artificial abrasives, as carborundum, crushed steel and artificial corundum.

CONTINUOUS CURRENT FOR POWER TRANSMISSION.

BY ALTON D. ADAMS.

Systems of transmission with continuous current may operate at constant voltage and variable current, at constant current and variable voltage, or with variations of both volts and amperes to correspond with changes of load. For transmission over long distances at high voltage, a system operating with constant current is well suited, because any desired voltage may be employed, though each dynamo or motor works at only a moderate voltage and each may be started and stopped independently of the others. As far as existing practice has gone a continuous-current dynamo of fairly large capacity is limited to rather moderate voltage. Constant-current dynamos intended for the operation of arc lamps in series are constructed for pressures up to 6,000 volts, but the current of such dynamos is seldom above ten amperes, giving, at most, a capacity of sixty kilowatts. Dynamos of several thousand kilowatts capacity each can readily be had at voltages of 500 to 600, but the attempt to construct dynamos to deliver more than two or three hundred kilowatts each at several thousand volts has encountered serious sparking at the commutator. Thus far, dynamos that yield between 300 and 400 kilowatts each have been made to give satisfactory results at pressures as high as 2,500 volts.

A result of these limitations is that where high voltage and large capacity are desired in a transmission with continuous current a number of dynamos must be operated in series. This is illustrated in one of the Swiss transmissions over a distance of thirty-two miles at 14,400 volts, the capacity being 2,160 kilowatts. To give this voltage and capacity, eight dynamos are connected in series at the generating station, each dynamo having an output of 150 amperes at 1,800 volts, or 216 kilowatts.

Another recent transmission in Switzerland is carried out at 23,000 volts, the capacity being 3,450 kilowatts. Ten dynamos are connected in series for this transmission, and each dynamo is rated at 150 amperes and 2,300 volts, or 345 kilowatts.

Continuous-current motors are, of course, subject to the same limitations as dynamos in the matter of capacity at high voltage, so that a series of motors must be employed to receive the high-pressure energy from the line. The number of these motors may just equal, or may be less or greater than the number of dynamos, but the total working voltage of all the motors in operation at one time must equal the total voltage of the dynamos in operation at that time, minus the volts of drop in the line.

In a constant-current transmission all the motors may be located in one place, as at a substation, or the motors may, as well, be scattered at any desired points along the line.

Each constant-current motor may have any desired capacity, but it must be designed for the current of the system. The voltage at the terminals of each motor varies with its load, being greatest when the motor is doing the most work. Constant speed is usually attained at each motor by means of a variable resistance connected across the terminals of the magnet coils. The amount of this resistance is regulated by a centrifugal governor, driven by the motor shaft. This governor also shifts the position of the brushes on the commutator to prevent sparking as the current flowing through the magnet coils is changed.

For a constant-current transmission the magnet and armature windings of both dynamos and motors are usually connected in series with each other and the line so that the same current passes through every element of the circuit, except that each motor may have some current shunted out of its magnet coil for the purpose of speed regulation.

In some cases, however, the magnet coils of the dynamos are connected in multiple with each other and receive their current from a separate dynamo designed for the purpose. With this separate excitation of the magnet coils, the dynamo armatures are still connected in series with each other and the line.

The total voltage at the generating station and on the line of a constant-current system varies with the rate at which energy is delivered, and has its maximum value only at times of full load. To obtain this variation of voltage it is the general practice to change the speed of the dynamos by means of an automatic regulator which is actuated by the line current. Any increase of the line current actuates the regulator and reduces the speed of the dynamos, while a decrease of the line current raises the dynamo speed. With a good regulator the variations of the line current are only slight. Under this method of regulation the dynamos in operation have a substantially constant current in both armature and magnet coils at all times, so that there is no reason to shift the position of the brushes on the commutator.

Generating stations of transmission systems are generally driven by water power and the speed regulator operates to change the amount of water admitted to each wheel. Each turbine wheel usually drives a pair of dynamos, but one or any number of dynamos might be driven by a single wheel. The two dynamos driven by a single wheel are generally connected in series at all times, and are cut in or out of the main circuit together. When the load on a constant-current generating station is such that the voltage can be developed by less than all the dynamos, one or more dynamos may be stopped and taken out of the circuit.

To do this the dynamo or pair of dynamos to be put out of service may be stopped, their magnet coils having first been short-circuited, and then a switch across the connections of their armatures to the lines closed, after which the connections of the armatures to the line are opened. By a reverse process, any dynamo or pair of dynamos may be cut into the operating circuit.

At the terminals of each dynamo in the series, while in operation, the voltage is simply that developed in its armature, so that the insulation between the several windings is subject to only a corresponding stress. The entire voltage of the line, however, tends to force a current from the coils of the dynamo at one end of the series into its frame, thence to any substance on which that frame rests and so on to the frame and coils of the dynamo at the other end of the series. To protect the insulation of the dynamo coils from the line voltage, thick blocks of porcelain are placed beneath the dynamo frames, and the armature shafts are connected to those of the turbines by insulating couplings.

Besides the switches, already mentioned, a voltmeter and ammeter should be provided for each dynamo and also for the entire series of machines. This completes the switchboard equipment, which is, therefore, very simple. As the line loss of a constant-current system is the same as to the rate at which energy is wasted, whatever the load that is being operated, this loss may be a large percentage of the total output when the load is light. If, for illustration, five per cent of the maximum voltage of the station is required to force the constant current through the line, the percentage of line loss will rise to ten when the station voltage is one-half the maximum, and to

twenty when the station is delivering only one-quarter of its full capacity.

In view of this property of constant-current working, the line loss should be made quite small in its ratio to the maximum load, as most stations must work on partial loads much of the time. Five per cent of maximum station voltage is a fair general figure for the line loss in a constant-current transmission, but the circumstances of a particular case may dictate a higher or a lower percentage.

On the thirty-two-mile transmission, above named, the loss in the line is six per cent of the station output at full load. The efficiency of constant-current transmission, where simply mechanical power is to be delivered, may be very high. Assuming a full-load efficiency of ninety-two per cent for each motor and generator, the motors will deliver as mechanical work $92 \times 0.95 \times 0.92 = 80.4$ per cent of the energy employed to drive the dynamos, if the line loss is five per cent. At less than full load the efficiency of transmission must be less than that just indicated. Where the constant-current transmission must deliver electrical energy in the form of either continuous or alternating current of moderate voltage for general distribution, the low-pressure current will represent at full load $92 \times 0.95 \times 0.92 \times 0.92 = 73.97$ per cent of the energy required to drive the dynamos at the generating station, if the efficiency of the line is ninety-five and that of the low-voltage dynamos is ninety-two per cent. In this case the constant-current motors are connected to and drive the low-voltage dynamos.

For the delivery of mechanical power the constant-current transmission requires dynamos and motors of two kilowatts total capacity, and for the delivery of low-voltage current dynamos and motors of three kilowatts capacity for each kilowatt of working capacity.

If a transmission with continuous current is to be carried out at constant pressure the limitation as to the capacity and voltage of each dynamo is about the same as with constant current. Probably more energy is now transmitted by continuous current at constant pressure than by any other method, the greater part being devoted to electric railway work at 500 to 600 volts. Dynamos for about these voltages can readily be had in capacities up to several thousand kilowatts each, but the length of transmission that can be economically carried out at this pressure is comparatively small. For each kilowatt delivered to a line at 500 volts and to be transmitted to a distance of five miles at a ten per cent loss in the line, the weight of copper conductors must be 372 pounds, costing $56.80 at fifteen cents per pound. This sum is about twice the cost of good continuous-current dynamos per kilowatt of capacity. If the distance of transmission is ten miles and the voltage and line loss remains as before the weight of copper conductor must be increased to 1,488 pounds per kilowatt delivered to the line, costing $227.20.

Experience has shown that in sizes of not more than 400 kilowatts, continuous-current dynamos may safely have a voltage of 2,000 each, and any number of such dynamos may be operated in multiple, giving whatever capacity is desired. At 2,000 volts and a loss of ten per cent in the line the weight of copper conductors would be ninety-three pounds, costing $13.95 at fifteen cents per pound for each kilowatt delivered to the line on a ten-mile transmission. With 2,000 volts on a twenty-mile transmission the weight of conductors per kilowatt would be the same as their weight on a five-mile transmission at 500 volts, the percentage of loss being equal in the two cases. Large continuous-current motors of, say, fifty kilowatts or more, can be had for a pressure of 2,000 volts, so that any number of such motors might be operated from a 2,000-volt, constant-pressure line entirely independent of each other. From these figures it is evident that a transmission of ten miles may be carried out with continuous current at constant pressure from a single dynamo with good efficiency and a moderate investment in conductors.

When the distance is such that much more than 2,000 volts are required for the constant-pressure transmission, resort must be had to the connection of dynamos and motors in series. Any number of dynamos may be so connected as in the case of constant-current work. The combined voltages of the series of motors connected to the constant-pressure transmission line must equal the voltage of that line, so that the number of motors in any one series must be constant. If the voltage of transmission is so high that more than two or three motors must be connected in each series, there comes the objection that motors must be operated at light loads during much of the time. Moreover, each series of motors must be mechanically connected to the same work, as that of driving a single dynamo or other machine, because if the loads on the motors of a series vary differently, these motors will not operate at constant speed. Continuous-current transmission at constant pressure with motors in series thus lacks the flexibility of transmission at constant current where any motor may be started and stopped without regard to the others in the series, the line voltage being automatically regulated at the generating station according to the number of motors in use at any time and to the work they are doing.

In the efficiency of its dynamos, motors and line, a constant-pressure system of transmission is substantially equal to one with constant current, at full load. At partial loads the constant-pressure line has the advantage because the loss of energy in it varies with the square of the load. Thus at constant pressure the line loss in energy per hour at half load is only one-fourth as great as the loss at full load. On the other hand, the energy loss in the constant-current line is the same at all stages of load. Because of these facts it is good practice to allow, say, a ten per cent loss in a constant-pressure line and only five per cent in a constant-current line at full load.

In a generating station at 2,000 volts or more constant pressure, it is desirable to have the magnet coils of the main dynamos connected in multiple and separately excited by a small dynamo at constant pressure. This plan is especially desirable where the armatures of several dynamos are connected in series to obtain the line voltage. Separately excited magnet coils make it easier to control the operation of the several dynamos, coils of low voltage are cheaper to make than coils of high voltage, and the low voltage windings are less liable to burn out. If a series of constant-pressure motors is in use at one point it may be cheaper and safer to excite its magnet coils from a special dynamo than from the line.

In a transmission carried out with series-wound dynamos and motors, the speed of the motors may be constant at all loads without any special regulating mechanism. To attain this result it is necessary that all the motors be coupled so as to form a single unit mechanically and that the dynamos be driven at constant speed. A transmission system of this sort may include a single dynamo and a single motor, or two or more dynamos, and two or more motors may be used in series.

When the dynamos of such a system are driven at constant speed and a variable load is applied to the single motor, or to the mechanically connected motors, both the voltage of the system and the amperes flowing in all its parts change together so that practically constant speed is maintained at the motors, provided

that the design of both the dynamos and motors is suitable for the purpose. With the maximum load on the motors the volts and amperes of the system have their greatest values, and these values both decline with smaller loads. The chief disadvantage of this system lies in the fact where more than one motor is employed all the motors must be mechanically joined together so as to work on the same load.

Compared with the constant-current system, this combination of series dynamos with mechanically connected series motors has the distinct advantage that neither the dynamos nor motors require any sort of regulators in order to maintain constant motor speed. It is only necessary that the dynamos be driven at constant speed and that both the dynamos and motors be designed for the transmission. In comparison with a constant-pressure system, the one under consideration has the advantage that neither its dynamos nor motors require magnet coils with a high voltage at their terminals and composed of fine wire or separate excitation by a special dynamo. These features of the system with series dynamos and motors, the latter being joined as a mechanical unit, make it cheaper to install and easier to operate than either of the other two. This system is especially adapted for the delivery of mechanical power in rather large units. The voltage available may be anything desired, but is subject to the practical limitations that all the motors must deliver their power as a mechanical unit, so that unless the power is quite large the number of motors in the series and, therefore, the voltage is limited.

An interesting illustration of the system of transmission just described exists between a point on the River Suze, near Bienne, Switzerland, and the Biberest paper mills. At the river a 400-horse-power turbine water-wheel drives a pair of series-wound dynamos, each rated at 130 kilowatts and 3,300 volts. These dynamos are connected in series, giving a total capacity of 260 kilowatts and a pressure of 6,600 volts. At the Biberest mills are located two series-wound motors, mechanically coupled and connected in series with each other and with the two-wire transmission line, which extends from the two dynamos at the River Suze. Each of these motors has a capacity and voltage equal to that of either of the dynamos previously mentioned. The coupled motors operate at the constant speed of 200 revolutions per minute at all loads and deliver over 300 horse-power when doing maximum work. Between the generating plant at the river and the Biberest mills, the distance is about nineteen miles, and the two line wires are each of copper, 275 circular mils, or a little more than one-fourth inch in diameter. The dynamos and motors of this system are mounted on thick porcelain blocks in order to protect the insulation of their windings from the strain of the full line voltage.

Either of the three systems of transmission by continuous current that have been considered requires a smaller total capacity of electrical apparatus for a given rate of mechanical power delivery than any system using alternating current. Equipment of the continuous-current systems should, therefore, cost less than the alternating for power alone.

If energy is to be delivered in the form of alternating current, the advantage lies with that system for the transmission, as to total capacity of apparatus and perhaps as to cost of plant. Where the transmitted energy must be delivered in the form of low-pressure continuous current, the relative capacities and costs of equipments for the two systems is often a close question.

Up to the present time the transmission of power by continuous current over long distances in the United States has been neglected. In Europe continuous current was early an important factor in long transmissions, later it has been still further developed and is being installed in competition with the polyphase system.

A Sixty-Mile Fifty-Thousand-Volt Power Transmission System.

At a recent meeting of the American Society of Civil Engineers, Mr. M. H. Gerry read an instructive paper on "High-Voltage Power Transmission," and described in detail the plant at Cañon Ferry, which has been in continuous operation for about a year. This plant is delivering power at Butte, Mont., sixty-five miles away, at 50,000 volts. After Mr. Gerry took charge of the plant, before its completion, some changes were made in the general plans with a view to securing better regulation. The original plans called for long penstocks, but, as is well known, this form of construction makes prompt regulation in speed exceptionally difficult. It was therefore decided to change this arrangement and install open forebays at a cost of about $150,000. The author held that next in importance to the form and amount of load on the station is the question of speed regulation. For many years close speed regulation was thought impossible for water-wheels driving machinery subject to suddenly varying loads; but the difficulties have been overcome, and it has been found that very satisfactory results can be obtained by correct designing and the use of proper governors to actuate the water-wheel gates. The first consideration is to have such hydraulic design that the water can pass freely to the wheels, and to avoid those arrangements which require a considerable change in the velocity of the water with varying gate on the wheels. It is said that there has been no interference, due to lightning, wind, rain or snow, with this transmission system. A telephone line is strung on the high-tension poles, and works very satisfactorily, the wires being about six feet from the nearest high-tension wire.

The Engineering Digest.

The *Engineering Digest,* a new weekly index and review of engineering literature, is announced by the publishers, D. N. Dunlop & Company, of Effingham House, Arundel street, Strand, London, W. C., England. The features of this periodical will be a survey of the principal articles contained in the British, American and Continental press, and a complete technical index of current engineering literature. Any section of this index can be supplied on cards for filing purposes. There will also be a section containing news items, and an illustrated interview with some leading man in engineering or scientific work. New books will be reviewed, and digests given of new catalogues and trade publications. It is also proposed to conduct a bureau for information and for employment in connection with the paper. The subscription price is sixpence per week or twenty-six shillings per annum.

Terrestrial Magnetism and Atmospheric Electricity.

The December number of *Terrestrial Magnetism and Atmospheric Electricity* contains a half-tone portrait of Benjamin Franklin, after the Gainsborough portrait now in the University of Pennsylvania, and a summary by Mr. L. A. Bauer of the results of the international magnetic observations made during the total solar eclipse of May 18, 1901, including results obtained during previous total solar eclipses. Mr. C. A. Farr gives records of earthquakes on quickly driven magnetographs. There is also an abstract of the magnetic observations on land, made by the Austrian Navy between 1896 and 1901, together with a number of interesting reviews of recent important scientific papers.

INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—X.

Notes on Progress in Europe and America.

BY JOHN B. C. KERSHAW.

Artificial Corundum.

This product, an impure crystalline form of alumina, is now being produced at Niagara Falls by the Norton Emery-Wheel Company. The method employed for the manufacture is based upon a patent granted to Jacobs, and was worked out at the experimental plant of the Ampere Electrochemical Company (see note 5). Bauxite, a mineral containing alumina and clay, is the raw material of the process. This is fused in an electric furnace by resistance heating between carbon electrodes, and is then allowed to cool slowly. The alumina crystallizes under these conditions, and is obtained sufficiently hard to be used as an efficient substitute for emery, while the silica, iron and other impurities are partly reduced to the metallic state by the action of the carbon, and are found as metallic buttons throughout the fused mass. When the latter is broken up these buttons are picked out. The bauxite, before submitting to the action of the electric current, is calcined by the aid of heat obtained from coal. The original experiments were carried out with a Horry revolving carbide furnace, but it has been found better to employ an electric furnace of the ordinary type, and to leave the mass of molten matter three to four hours in the furnace before removal, after the current is cut off. The product of the Niagara works, which, according to Richards, is now utilizing 500 horse-power in the manufacture, is shipped to Worcester, Mass., where wheels, stones, cloth, etc., are manufactured with this artificial corundum, as a substitute for emery. Owing to the increasing use of grinding tools in engineering work, this new electrometallurgical manufacture may have a successful future, but it will have a keen competitor in the Acheson carborundum industry, also centred at Niagara Falls, and a war of prices is likely to set in, unless some amicable selling arrangement is made between the rival companies.

Bullion Refining.

The electrolytic processes for refining silver and gold bullion offer many advantages over the older dry or wet methods of separation, and it is, therefore, not surprising that electrolytic bullion refineries are now to be found in all the leading industrial countries. According to Ulke three electrolytic silver refineries are in operation in America, and one of these refines 100,000 ounces of silver bullion per day. The Wohlwill gold refining process, also electrolytic, has lately been adopted by the Philadelphia Mint. Germany possesses three bullion refineries, located at Hamburg, Frankfort and Pforzheim, respectively, and the Wohlwill gold refining process has recently been adopted by the Freiburger u. Halsberger Huttenwerken. France also is operating the Wohlwill process. English bullion refiners are very chary in giving information about the methods in use, but the writer has strong ground for the belief that electrolytic methods of separation are employed by two firms, with refineries in London and Birmingham, respectively.

As regards methods, silver is usually electrolytically separated in a silver nitrate solution, while the Wohlwill process for parting gold is based upon the use of an acid electrolyte of gold chloride. Dietzel has recommended the use of an electrolyte of copper nitrate for silver alloys, and this process is in use in Pforzheim, in Germany. The estimates of output by the various refineries vary considerably, and official figures are not easily obtained. In 1901 it was, however, stated on good authority that the value of the annual output of gold and silver by the Frankfort and Hamburg bullion refineries amounted to $12,000,000, and, according to Daneel, the latter refinery is producing 100,000 kilogrammes of silver, 3,000 kilogrammes of gold and fifteen kilogrammes of platinum per annum. The Deutsche Gold u. Scheide Austalt, the owner of the Frankfort refinery, has recently increased its capital by $360,000, and in 1902 this company paid a dividend of sixteen per cent.

The Desolle Copper Process.

In all processes for the electrodeposition of copper the difficulty of obtaining a dense adherent deposit, with high-current densities, is met, and, as a rule, the required characteristics of the deposited copper can only be obtained by working at a low rate of deposition with low-current densities. On this account a very large amount of capital has to be sunk in plant, and in copper for stocking the depositing vats, in order to obtain a large output of deposited copper. Several patents have been taken out relating to methods for increasing the current density (and therefore the rate of deposition) without sacrifice of the desired metallic characteristics of the deposited metal. One of the latest of these is that of Desolle. This patented procedure has recently been reported upon by H. Fountaine, acting for the French society "d'Encouragement des Arts Economiques," and this society has bestowed a bronze medal upon M. Desolle for his invention. The Desolle process is in operation upon a small scale at the works of Levallois-Perret, in France, and also at a works in Birmingham, England. The chief novelty of the Desolle process is said to lie in the use of the electrolyte under pressure as a jet. In this way a current density of 750 amperes can be safely employed, and a deposit at the cathode one millimetre in thickness, obtained in the comparatively brief space of fifteen hours. The Desolle process is intended specially for application to articles of any shape or form, constructed of iron, steel or zinc. A "striking" bath composed of double cyanides of potassium and copper is first used, and after rinsing the articles with the thin coating of copper produced by the immersion in this bath they are transferred to the depositing bath. The proposal to use jets by aid of which the electrolyte is forced against the surface of the cathode is, however, not new in the electrolytic copper industry, and it is doubtful whether the Desolle patent, in view of these earlier trials, is valid. In 1897 the present writer referred to the use of jets by Thofern in the electrolytic copper refinery at Anaconda, U. S. A. In this case it was found that the gain in speed of deposition did not balance the increased cost of operating, and the use of jets was discarded after a short trial. In 1898, before the Royal Society in London, Mr. J. C. Graham showed an experimental cell in which copper was being deposited at a high rate by aid of a pressure jet, and on this occasion it was stated that a current density of 2,000 amperes per square metre could be employed without danger to the smoothness, cohesion or other metallic nature of the deposit.

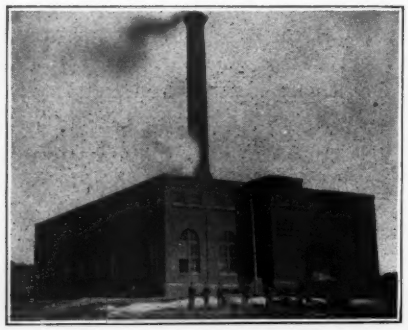
Blasting in shafts by the use of the galvanic battery is now successfully accomplished by employing what are termed "delay fuses." These are fuses which require time—the fraction of a second—to cause an explosion. By this means "cutting holes" may be fired first, the intermediate "sinking holes" next and the "squaring-up" holes last. The great damage to timber often resulting by the simultaneous discharge of the full round of holes is thus avoided to a great extent, and the miners do not have to run the risk incident to "spitting" a large number of holes.

The Colorado Springs Electric Company.

A Modern Installation for Lighting and Power.

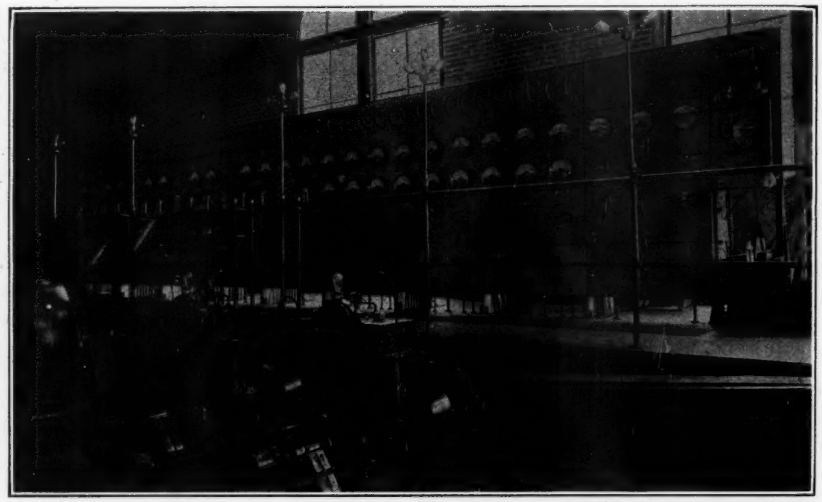
By J. H. Rusby.

ONE of the most interesting, largest and most modern plants in Colorado Springs is operated by the Colorado Springs Electric Company and distributes current for both power and lighting in Colorado Springs, Colorado City and Manitou.

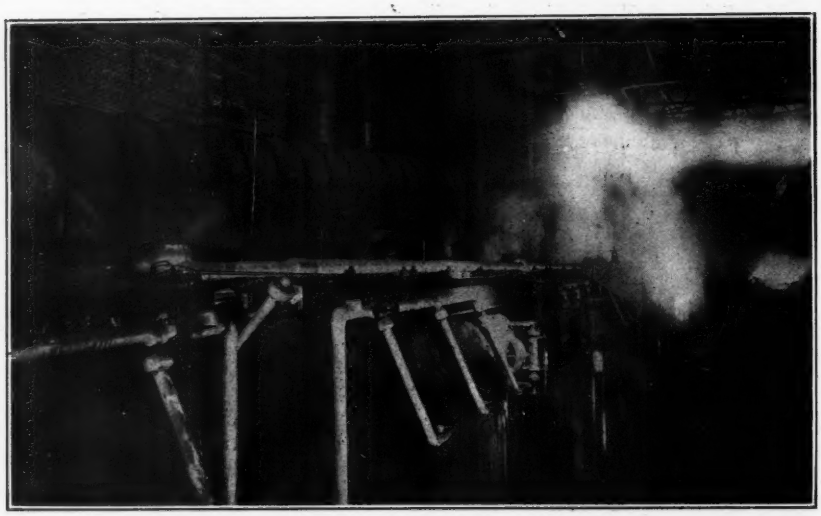


MAIN GENERATING PLANT—EXTERIOR—COLORADO SPRINGS ELECTRIC COMPANY.

The company was organized in April, 1900, under the laws of the state of Colorado, and at that time took over the business, plant and franchises of the El Paso Electric Company, which company had been operating in Colorado Springs for a period of about twelve years. The plant of the El Paso company was located in the downtown or business section of the city, and is now used principally as a distributing and heating station.



MAIN GENERATING PLANT—SWITCHBOARD—COLORADO SPRINGS ELECTRIC COMPANY.



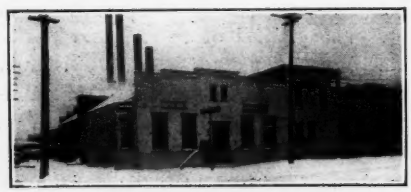
MAIN GENERATING PLANT—BOILER ROOM—COLORADO SPRINGS ELECTRIC COMPANY.

The main generating station is located at Austin Bluffs, at a point six miles northeast of Colorado Springs. This location was chosen because of the close proximity of extensive lignite coal banks, operated by a local coal company. This furnishes a source of very cheap fuel in the form of slack, or mine-run when the supply of slack does not suffice. The mine is situated about 1,500 feet from the power-house and the coal is transported from the mine by a two-car gravity-surface tramway to a coal conveyor, which distributes the coal to the bins in front of the boilers.

A good supply of water is obtained from a large pipe line running close to the plant and supplied from a reservoir in the mountains to the north. By analysis this water is shown to be very suitable for boiler purposes. A settling reservoir of 500,000 gallons capacity serves as a reserve between the pipe line and boilers.

POWER-HOUSE.

The power-house is of red pressed brick, with sandstone trimmings, adequately lighted by large windows. The roof is supported on steel trusses extending the entire width of the building, and supported near the centre by a brick partition, which divides the engine room from the boiler room. The floor of the engine room is supported on steel beams resting on cast-iron bearing plates in masonry walls.



EXTERIOR OF SUBSTATION, COLORADO SPRINGS ELECTRIC COMPANY.

In the engine room there is a twenty-ton, hand-power Maris Brothers' traveling crane, which spans the entire width of the room, running the full length of the power-house on 60-pound T-rails placed on heavy I-beams, which are in turn supported on brick pilasters built up from the building foundation.

The boiler room is 60 feet by 160 feet 9 inches. Its floor level is nine feet below the floor level of the engine room. There are five Aultman-Taylor boilers, of the Cahall horizontal, sectional, water-tube type, of 400 horse-power each, and set in five batteries; two Babcock & Wilcox water-tube boilers of 500 horse-power each, and set in two batteries, thus

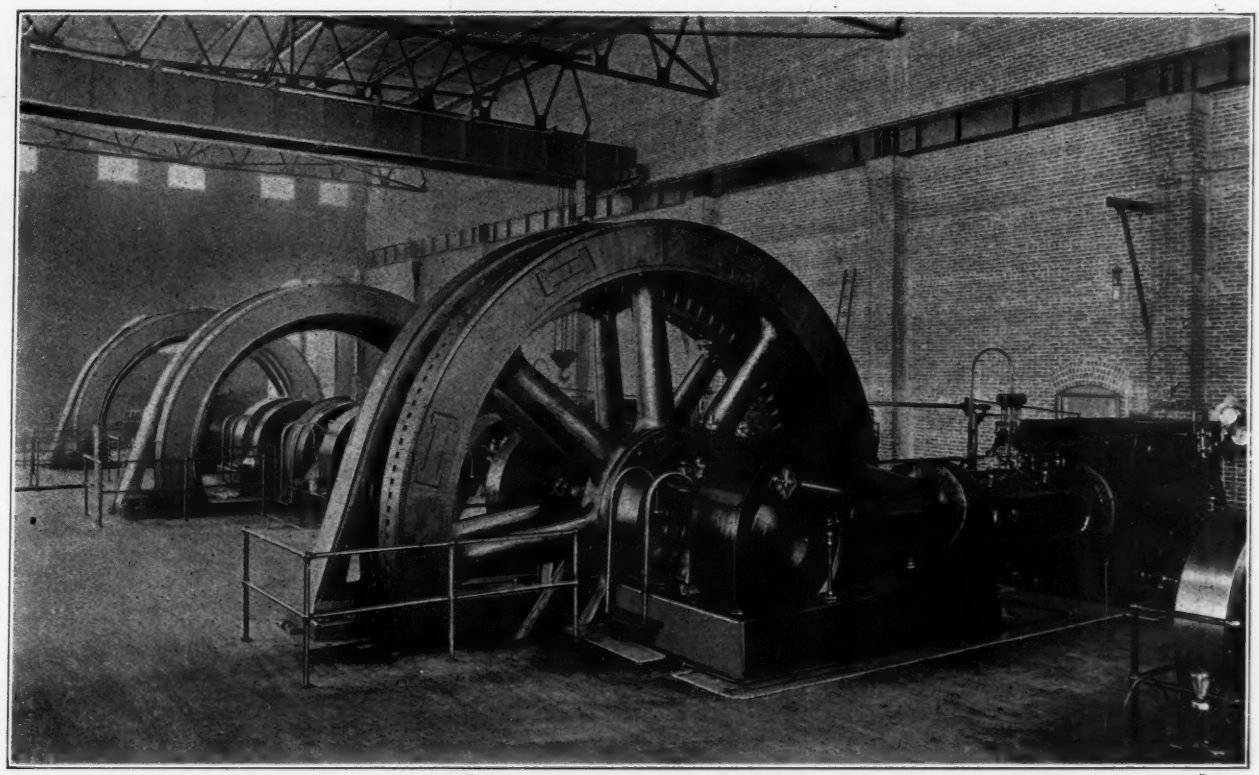
making an aggregate of 3,000-horse-power boiler capacity in commission; the working steam pressure is 160 pounds. Natural draught is used. The stack is steel, self-supporting, 101 feet 6 inches high, above capstone of pedestal, and is 9 feet 6 inches inside diameter. The pedestal is built of brick and extends from the foundation to a height several feet above the roof of the building. The total height of stack and pedestal is 170 feet.

The stack and structural steel work for roof and floor were furnished by the Gillette Herzog Manufacturing Company. The steam piping is designed on the feeder and main principle, and embodies three units, with provisions for a fourth unit. The engines are horizontal, cross-compound, non-condensing type, 24 inches and 44 inches by 48 inches. They were built to develop 1,500 indicated horse-power when operating at 150 pounds steam pressure and running at 90 revolutions per minute. The engines were built by the International Power Company. Each engine is direct-connected to a General Electric 750-kilowatt, three-phase, 6,600-volt revolving field generator. To facilitate parallel operation and uniformity of rotation each unit carries a large flywheel twenty feet in diameter, weighing 70,000 pounds. These units are operated in multiples and no difficulty is experienced in successfully accomplishing parallel operation.

Two main exciters of General Electric make, fifty kilowatts capacity, 125 volts, direct-coupled to Ames Iron Works high-speed engines, are sufficient for maximum demand of the plant, but, as a reserve, two fifteen-kilowatt Edison bipolar generators, belted to a fifty-horse-power, 460-volt General Electric induction motor, were installed.

The switchboard is of marble with all necessary measuring instruments and duplicate bus-bars, with a panel to each engine unit and each outgoing circuit, and also a panel for exciters. All main switches are of the three-pole, double-throw, oil type. All switches, rheostats, instruments, transformers, etc., are placed below the floor, and are hand-operated from switchboard panels. One piece of apparatus of especial interest in the plant is the automatic voltage regulator installed by the General Electric Company. This operates on the shunt field of the exciters and maintains a remarkably even potential on the alternating bus-bars, notwithstanding that the load on the system is a mixed one of motors and lights.

No step-up transformers are used, as the alternators generate at 6,600 volts—the voltage on the transmission system. Experience has shown that main-line fuses are not necessary, the generators being able to withstand the few short-circuits that come in, and the oil switches safely breaking a dead short-circuit.



MAIN GENERATING PLANT—ENGINE ROOM—COLORADO SPRINGS ELECTRIC COMPANY.

long sweeps from boilers and headers, and long, easy bends to engines, thus avoiding angles and elbows in the path of the steam. Between engines and header are separators, which serve as steam reservoirs as well as separators.

Each engine exhausts into a common cast-iron header, from which the exhaust steam is led through a spiral riveted pipe to the roof and passes through a Warren exhaust head to the air. The feed water is heated by exhaust steam to 198 degrees Fahrenheit.

ENGINE ROOM.

The engine room is 58 feet 8 inches by 160 feet 9 inches, and contains at present

TRANSMISSION SYSTEM.

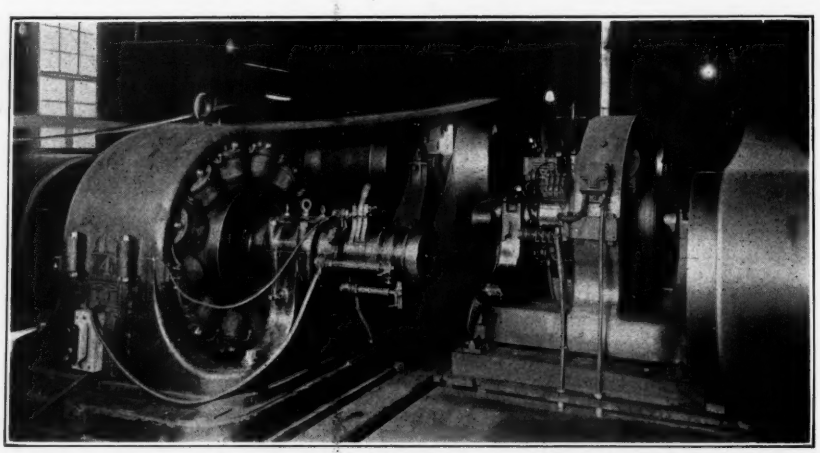
The transmission system is arranged in the form of a triangle with the Austin Bluffs station at the vertex, and the Colorado Springs substation and United States Reduction and Refining Company's mills at Colorado City at the base angles. A connecting base line connects the points above mentioned, making in all about fifteen miles of line, thus a duplicate pole line is available for enhancing continuous service. Each pole line carries a double

circuit of three No. 1 B. & S. gauge copper wires arranged in two sixteen-inch triangles and carried on triple petticoat insulators. In general, the poles are thirty-five feet, white cedar, set 100 feet apart. No treatment was given the butts, the soil in this locality being of such a nature that this was not deemed necessary.

SUBSTATION, COLORADO SPRINGS ELECTRIC COMPANY—SWITCHBOARD.

At the substation in Colorado Springs the voltage is stepped down from 6,600 volts three-phase to 2,300 volts two-phase. From the secondary bus-bars the distribution is single-phase, 2,300 volts, each circuit being controlled by a General Electric M. R. regulator for lighting Colorado Springs and Colorado City. The power for all motors operated in the commercial district of Colorado Springs is supplied by 500 volts direct current generated at the downtown plant.

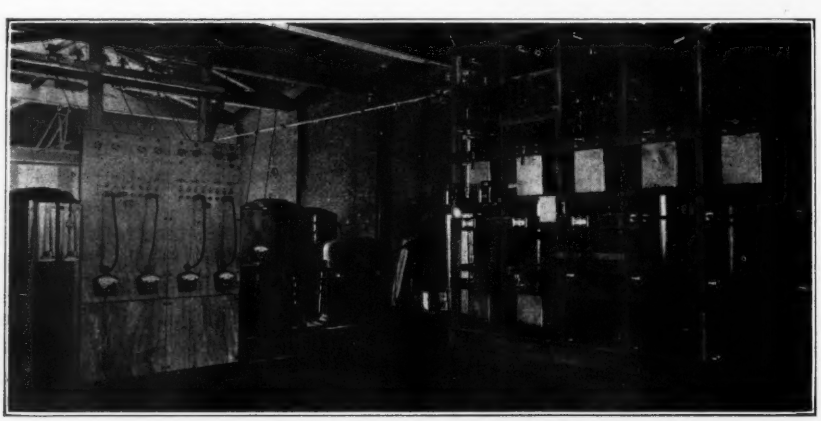
In the winter months, for the purpose of heating by exhaust steam, an engine is operated at this station to drive one 150-kilowatt and two 75-kilowatt, direct-current generators, and also one 150-kilowatt alternator operating in multiple with the Austin Bluffs plant. In the summer the direct-current machines are driven by a synchronous motor running from the 2,300-volt busses. A three-phase alternator will be installed during the next few months at the substation, and then the secondary system will be changed from two-phase to three-phase. The substation plant also contains five 45-light tub transformers which are connected to the 6,600-volt transmission feeders, and which operate the series enclosed city arc system. The engine equipment of this station includes one twenty-four-inch by forty-eight-inch simple non-condensing Frick-Corliss and one 100-horse-power Westinghouse engines, the boiler plant consisting of 1,500 horse-power in water-tube and tubular boilers, with all necessary feed-water heaters, pumps, etc.



SUBSTATION, COLORADO SPRINGS ELECTRIC COMPANY—PART OF GENERATOR ROOM.

A large part of the power load of the general system is located in the large ore reduction mills, which handle most of the Cripple Creek ore. Each mill has its own substation and is operated entirely by electric power, the total horse-power connected in motors aggregating 4,000. The voltage is stepped down for motor service from 6,600 to 460 volts. The motor load is a mixed one of induction and synchronous motors, and the three-phase distribution is followed throughout.

The greatest danger to transmission in this locality is from the effects of lightning, which has given some considerable trouble in the past, but by a careful study of the conditions to be met this difficulty has been practically overcome.



SUBSTATION, COLORADO SPRINGS ELECTRIC COMPANY—SWITCHBOARD AND TRANSFORMERS

One of the most interesting features of the operations for 1902, at least to central station managers, was the record made in load-factors, the average of all daily load-factors for the year 1902 equaling 52.6 per cent. This particularly desirable feature is effected because of the constant load obtained from the reduction mills which operate twenty-four hours each and every day during the year.

The city of Manitou obtains its supply of current for lighting and power purposes from the Manitou Electric Company, which in turn buys the electrical energy from the Colorado Springs Electric Company. The current is transmitted from the main power station at Austin Bluffs to the city of Manitou at a pressure of 6,600 volts, the distance approximating ten miles. The electrical energy is then dis-

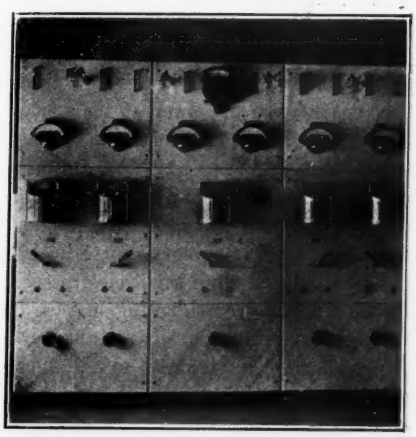
tributed in Manitou from a substation, an illustration of which is shown.

The writer is indebted for information concerning the plants of the Colorado Springs Electric Company to George B. Tripp, general manager, and E. P. Dillon, electrical engineer.

MANITOU ELECTRIC COMPANY.

The Manitou Electric Company, Mr. Peters, manager, operates under a franchise from the town of Manitou, Col.

It purchases its power from the Colorado Electric Company, and this power enters its substation on Manitou avenue at 6,600 volts, three-phase, 7,200 alternations, 60 cycles, through lightning arresters and cable plugs, into the basement and through kick coils and additional lightning arresters to a primary switchboard which is fitted with two oil-break switches and fuses, thence to two pairs of transformers of Westinghouse oil-cooled type of thirty-five kilowatts capacity each. Current is delivered in these transformers at three-phase, and leaves



MANITOU ELECTRIC COMPANY SUBSTATION SWITCHBOARD.

at two-phase, four-wire secondary, 1,040 volts, to four bus-bars, each bar having a single-pole, quick-break knife-switch. From this point it is taken up to a secondary switchboard on the first floor, shown in the illustration, which board is fitted with two pairs of two-phase, 1,040-volt bus-bars.

From these bars which are fitted with voltmeters five circuits are led, each circuit through an oil switch, Thompson recording wattmeter, ammeter, Noark fuses and General Electric regulating coils laid in oil to the various street circuits supplying the town. These street circuits enter line transformers at 1,040 volts and leave on the three-wire, 220 to 100-volt system to consumers.

The Lighting of the Universal Exposition of St. Louis.

An effort will be made in the electric lighting plans for the Louisiana Purchase Exposition, at St. Louis, to make the night picture entirely different from the day picture, so that two distinct artistic compositions will be presented to visitors. By day the columns which form the colonnades around the central avenue will be the most noteworthy feature of the main picture. These will stand out white and imposing. At night the columns will be silhouetted darkly against walls of light. This effect will be produced by inserting in the rear fluting of the column a close line of eight-candle-power incandescent lamps, and by peppering the recessed ceiling of the cloister with lamps of similar power. These lamps will not be seen from the outside. The front columns will not be lighted except by the diffused lamps in the avenue. To a spectator at a moderate distance the columns will be dark projections on the intense white of the screened wall. During the day this wall and recessed ceilings of the cloisters will attract little attention, because they will be in deep shadow.

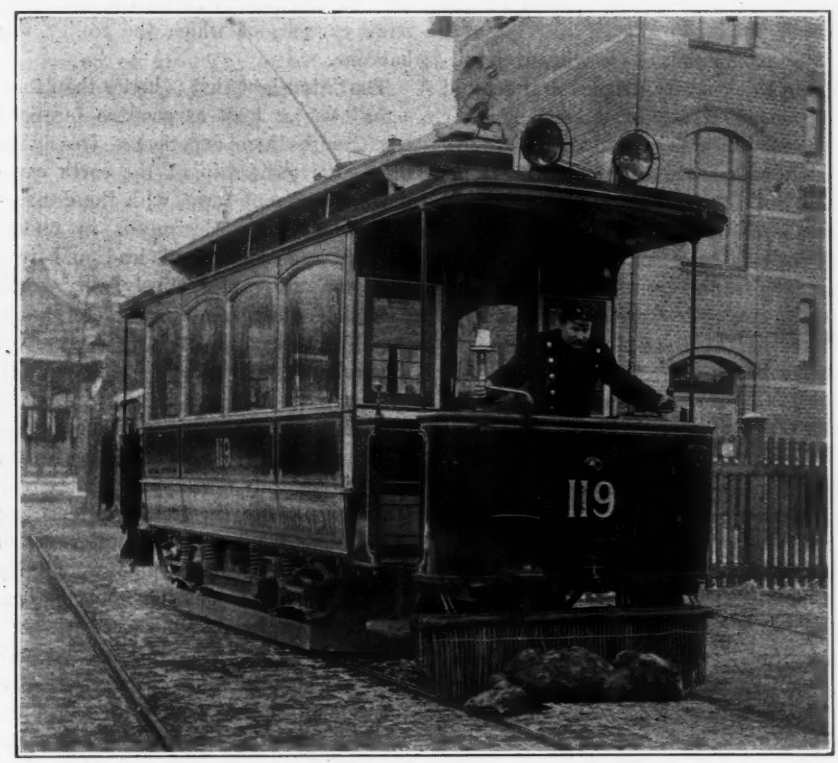
This is the plan which Chief Rustin has devised for the Varied Industries Building, and, it is announced, will be typical of the whole treatment. The architect has supplied plastic decorations which will lend themselves to harmonize with the illuminating effects. The frieze of the cornice which runs completely around the building has, at regular intervals, a large white wreath enclosing the letters "N. J." in a monogram, these being the initials of Napoleon and Jefferson. A three-lamp cluster will be placed in the centre of the wreaths. The cornice line will be marked at intervals by lamps so disposed as to light the cornice throughout its height. The plan for lighting the domes has not yet been definitely fixed, and this will be deferred until the staff decorations are more fully developed. The interior lighting of the exhibit buildings will be by arc lamps.

A NEW CAR FENDER.

BY EMILE GUARINI.

A number of fenders has been invented to prevent accidents to persons and animals from electric cars, but none has been entirely effective. Dr. Walter Hirt, of Breslau, Germany, has designed a fender which seems to be very reliable. The inventor believes that if the members of the victim can be forced against its body, collision and subsequent dragging will not have any serious consequence, and his apparatus is designed to fulfill this condition.

The apparatus consists of a sort of brush, formed of twelve rows of rattan placed under the front platform. It requires no action whatever from the motorman. Tests have been carried out at the electric railway depot in Breslau in the presence of competent judges. A dead deer, weighing fifty kilogrammes, was experimented with, and then a large dog. In each case the obstacle was placed, first, with the feet toward the car, and then with the back, and the car was driven at it at all speeds and braked at the moment of collision. The body of the deer was pushed for eight or nine metres. The legs were pushed up against the body, and the collision had no serious effect. In the first test made on the dog, the animal was pushed four and one-half metres. The legs were pressed up against the body, but no injury resulted from the blow. In the second instance, the dog was thrown 7.7 metres and turned over three times. The body was then examined, but it could not be seen that it had suffered any injury or damage whatever in its general condition.



NEW CAR FENDER.

THE EFFECT OF WIRELESS RADIATION ON AERIAL CONDUCTOR SYSTEMS.

BY JOSEPH B. BAKER.

The practice of a new art, especially a new electrical art, nearly always brings with it the temporary hardship to existing systems. This may be due either to direct competition during the period of adjustment of public demand, or to an overlapping or infringing of functions of operation. In some instances, appeals to the courts are necessary to define the rightful limits of possession by each of the litigating corporations of what was regarded by all the world as common property before the development of the new art.

The introduction of electric street railways in this country proceeded at a rapid pace, characteristically American, after the feasibility and economy of the trolley had once been demonstrated. This furnishes an illustration of the industrial fact above stated, for, while the system —to call it such—of raising horses to meet the rapid consumption of horse flesh in street-car service of the country suffered hardship and finally absolute extinction by the universal adoption of the trolley, the new traction method found itself face to face with an opponent to its development which could not be disposed of by a like simple exercise of the law of the survival of the fittest. The use of the earth return for the new electric car systems was hotly contested by the telephone companies, and expensive litigation was inaugurated, with the ancient and classic proposition—"the earth is a conductor of zero resistance"—as a battleground.

The "hindsight" of a few years later sufficed to show the obstacles to both industries lying latent in the proposition, that had originated from the discovery of the "earth return" by Steinheil, and which contained an inherent fallacy that had slumbered during the development of the telegraph, and now, for the first time, showed forth its limitations. These were individual obstacles, quite apart from the controversy between the electric railway and the telephone interests over the sole possession of the earth return.

The electric railway men learned, quite apart from their struggle for the exclusive use of the earth return, that there was such a thing as a very definite, though small, fall of potential through the ground used as a return conductor, and that it meant electric power wasted, and, therefore, a too rapidly diminished coal pile when it was multiplied by the comparatively large current required by the new power for propelling cars.

Telephone men learned that the noise and cross-talk on their line that had become a serious impediment to the use of the telephone commercially, and an almost positive bar to its extension, was a real and insistent obstacle. It no longer could be dismissed with the vague and meaningless explanation "induction," as the trouble in very large part was an unbalancing and leakage due to the same fact that there was a definite fall of potential through the earth when used as a conductor, whereby each telephone deliberately connected to the earth was made a vociferous receptacle of all the new and rapidly increasing sources of stray current, of which the trolley was but one.

The "hindsight that is better than foresight" was at least as good as foresight when, with these experiences freshly in mind, the ownership of the earth came up in a different form, with the destruction wrought by electrolysis in underground lead cables and lead and iron pipes by the comparatively very small potential differences that were established between the return feeders of the trolley system and the metal pipes in contact with the earth return. Here the community of interest was, in most cases, recognized, and the remedies suggested by cooperative study were applied, in the realization that both the trolley systems and the systems for distributing water, gas or electricity through metal pipes were living industrial propositions that must be harmonized, because they must coexist.

Coming now to the subject of this article, what does the rapid extension of wireless signaling have in common with the illustrations cited above from electrical history in the matter of probable conflict of electrical operation? The trolley *versus* telephone controversy was concerned with the utilization of the earth as a part of the circuits of distribution employed by the respective interests, but the general introduction of wireless systems involves the adjudication of the whole of space. The case differs from that of power distribution for electric cars, in which the trolley companies have been left in undisputed possession of the earth as a branch of their return circuit, with only the limitations of coal economy and of the liability of electrolysis damage suits. For the wireless telegraph, whatever may be the correct presentation of the propagation of electrical disturbances, by means of which wireless messages are sent, it is broadly true that, with the exception of the terminal apparatus itself, the whole of the connecting medium between the termini is common and non-individual, in contradistinction from the special and individual nature of a wire telegraph line. It is also broadly true that the oscillatory discharges of the vertical wire or antennæ at the sending station give rise to the propagation of electric waves in the surrounding space—a rhythmical, etheric disturbance, of which a minute portion affects a coherer or other receiving device situated at a distance enormously great compared with the dimensions of the terminal apparatus. The electromotive forces sufficient to cause a distinct receiving of signals are developed in an antenna, of length approximately similar to that of the sending antenna, but yet subtending an infinitesimal angle with the sending station. The angle subtended for transatlantic distance, for example, is so definitely limited by structural difficulties in building high towers that an increase of power at the sending end is practically the only way to cover the distance by the present wasteful methods of space telegraphy. In other words, a very great disturbance must be made at the centre of an imaginary sphere in space in order that even the small electromotive forces necessary for signaling may be developed in an electrically attuned conductor, forming a tangent to the sphere of infinitesimal length compared to the sphere's radius.

The electromotive forces sufficient for signaling are minute indeed, but still they are appreciable by a coherer. But now consider the sending and receiving antennæ moved closely together, the two antennæ systems being electrically in tune with each other. Clearly, with the amount of energy at the sending station undiminished, there will be developed in the receiving system very considerable electromotive forces. The electric radiation of power to work a coherer across the 3,000 miles of the Atlantic may now be sufficient to develop visible sparks across an air-gap in the receiving system now located within three miles, or one one-thousandth of the distance. If we now pass from our hypothetical case of the moved-up deliberately attuned antenna to that of a system of aerial conductors installed for some purpose of electrical distribution within the stated three-mile limit, it is imaginable that such a conductor system might possess in the summation of its electrical constants an accidental resonance, or near approach to resonance, whereby surgings of current would be set up in it as a whole or in

one of its ramifications by an artificial thunder-storm applied in the vicinity. If we further conceive that spark-gaps exist in our accidentally attuned circuit, such as the open-space lightning arresters, if it is a telephone or telegraph circuit, or a narrow break in some open translating device or a loose joint in the wiring, we have an opportunity for a fire whose origin would certainly be of the mysterious class whose cause it is the fashion to assign to defective electric wires. At any rate, there will be a possibility of grounding the circuit and rendering it inoperative.

With sufficient proximity to such powerful thunder-stations as those Mr. Marconi is sprinkling about so plentifully, exact, or even approximately exact, tuning is not needed in the "wire" commercial circuit referred to to fill the case above imagined, for forced vibrations may be impressed in a non-resonant or aperiodic electrical circuit just as they are in accoustics if the excitation be sufficiently powerful. The circuits may be merely typical, and contain only an elementary arrangement of capacity and inductance sufficing to illustrate the possibility of an approach to resonance. The telephone substation indicated might be located at the top of a modern skyscraper which would help the imagined condition for development of secondary electromotive forces through the fact that the vertical projection of the system would compare favorably in height with the sending antenna. Of course the differing dielectrics in, and the distribution of, the capacity elements in the two cases would have a bearing probably in the long run adverse, on the probability of setting up surgings in our circuit that would be capable of sparking across at the carbon plate arresters or of setting a fire by arcs at the terminals of the substation inductances; and the relatively higher ohmic resistance and the greater opportunity for displacement currents in the lines and translating devices of this circuit would probably be considerations operative on the same side of the question.

In conclusion, the following points, suggestive to the writer in connection with the subject of the present article, have come to his attention as matters of record in the history of space telegraphy. It has been rumored in the electrical press that the operation of Marconi's big Cornwall station effectually "drowned out" other wireless experiments in his vicinity in the United Kingdom in spite of the exact selectivity claimed for the apparatus at that station. The newspaper items printed at the time of the transatlantic demonstration at Wellfleet, Mass., stated that the telegraph and telephone service in the vicinity was put out of order by the wireless tests. In Fahies's books on the history of wireless telegraphy is described the effect of a thunder-storm upon the operation of an electroplating establishment. The vat wiring was full of bad joints, and although this system of wiring was certainly not attuned, in the parlance of the day, the coherer effects of the flashes of lightning in the vicinity were sufficient to make minute welds at the joints in the wiring, which, by lowering the resistance, caused an excessive current to pass through the electroplating solution making it "boil" and spoiling the work. Finally, to show that the possibility of setting up such forced oscillations was thought possible by some, it was proposed in the early days of wireless telegraphy, and has since been revived, to explode the magazines of a hostile warship by sparks developed therein, or to melt the armor plate on the same unfortunate vessel by sympathetic or forced electrical vibrations.

All of these stray thoughts are not to be taken seriously by themselves alone, but are indications of an underlying ever-real set of phenomena containing elements of conflict with existing electrical distribution systems which should be anticipated and provided for against the day of the general use of transmission of electrical energy through space without wires for telegraphic or telephonic signaling or the transmission of power.

University of Wisconsin Branch of the American Institute of Electrical Engineers.

A meeting of the Madison, Wis., branch of the American Institute of Electrical Engineers was held in the Engineering Building of the University of Wisconsin on Thursday, March 12. The papers on "Railway Car Lighting," read at the 173d meeting of the Institute in New York city, February 27, were abstracted by Mr. E. B. Mueller. This was followed by a general discussion of the subject by the members present.

This local chapter was organized in October, 1902, and meetings are held weekly throughout the college year. The papers read at the monthly meetings of the Institute are taken up at one meeting of each month, and the remaining sessions are devoted to other engineering subjects of interest.

Professor B. V. Swenson is chairman, and Mr. G. C. Shaad is secretary of the chapter.

The Magnetic Effect of Moved Dielectrics.

Many experiments have shown the magnetic effect of an electric charge when in motion. Rœntgen has, furthermore, shown that when a dielectric is moved through an electric field there is a magnetic effect set up, but his apparatus was not sensitive enough to give any quantitative measurements. H. Prender has investigated this phenomenon by setting up an alternating electric field from alternating electric charges, and by revolving in this a hard rubber disc. A synchronous commutator collected the induced currents, which were then measured by a galvanometer. The subject has been studied further by Herr A. Eichenwald with a very simple apparatus, but which has given some very satisfactory results. The apparatus consists of three discs, two of which are connected to a shaft by means of which they may be rotated. Dielectrics of different kinds can be inserted between these two discs. The third disc is stationary, and placed to one side of the two rotating discs. All three are protected by guard rings. The two rotating discs were covered with tin-foil in the form of a flat spiral, each turn of which had a certain constant area. Through this spiral a galvanic current may be passed, and the effect of this compared with a moving charge. With this apparatus the following experiments could be made: Two discs covered with tin-foil could be charged and rotated singly or together, and the Rowland effect observed. Different dielectrics can be inserted between the two rotating discs, and measurements made to determine whether the dielectric constant has any effect upon the phenomena. Next, the two rotatable discs may be held fixed, and a dielectric disc rotated between them, and the Rœntgen effect observed. Finally both the rotating discs and the dielectric can be revolved, giving an effect due to the superposition of the Rœntgen effect upon the Rowland effect. Every precaution was taken to eliminate errors and disturbing factors. It is found from these readings that the kind of dielectric material has no effect upon the results. It was also shown that an imaginary charge might be assumed upon the moving dielectric which behaved precisely as a convection current. In considering this, three assumptions are possible—first, the effect may be due to the absolute motion of a charge in space, or to the motion of a charge relative to the dielectric, or to the motion of a charge relative to its electric field. The third assumption is the only one which agrees with the results. These results can only be explained if the ether is absolutely quiet, not only surrounding, but even throughout moving dielectrics. It is the author's intention to carry these investigations further.

Notes from Great Britain.

By Our Special Correspondent.

IN 1897 a weights and measures act was passed in Great Britain rendering permissible the use of the metric system of weights and measures. This was a modification of an attempt to compulsorily enforce the metric system, and, *a priori*, the adherents of that system of weights and measures have cherished the idea ever since. At the conference of colonial premiers in London last year, one of the resolutions passed was to the effect that the introduction of the Continental method would be an advantage throughout the empire, and possibly, as a direct outcome of this, another bill is to be promoted before Parliament in the coming session to give effect to the same provisions that were deleted from the 1897 act.

Before more than one scientific society of late has the matter been discussed, but chiefly by men of minor public importance. A discussion by a large number of influential scientific and manufacturing men, however, has, on the eve of the opening of Parliament, taken place at the Institution of Electrical Engineers, and, as a guide to the opinions of those likely to influence the final result, a deal of importance attaches to it.

First of all, Mr. Alexander Siemens, who is head of the house of Siemens Brothers & Company, in England, opened a debate in favor of the metrical system. It is now a pretty well-known fact that practically the only countries where the system is not in universal use are Great Britain and her colonies, the United States and Russia, and in these circumstances, as many have done before, he laid stress on the convenience to international trade which would follow the conversion of the countries in question. With a sublime indifference, however, for the finer points of international etiquette, such men as Sir John Wolfe Barry, K. C. B., Colonel Crompton and several other representative speakers ridiculed the suggestion of pandering to Germany and other Continental protectionist countries when we received no reciprocity whatever. In addition, these speakers urged that as all those who desired could use the metric measures whenever they pleased, what need was there to force it upon others who did not wish for it?

Mr. Siemens, however, was by no means a solitary advocate of his own views, for he was supported by no less eminent men than Sir William Preece, Sir Andrew Noble and Mr. Thomas Parker, who, by the way, was not satisfied that the units of the metric system were satisfactory, although the system itself was. His proposal was that if the use of the British inch was to be permitted as a metrical unit, and the weight of a cubic inch of water be legalized, all the present difficulties would disappear. Sir William Preece and Sir Andrew Noble were both convinced that sooner or later we should have to resort to the metric system in its entirety. The latter speaker characterized the present British system as entirely haphazard, while Sir William Preece, continuing the spirit of levity which predominated throughout, mentioned a proposal for a ten-day week.

On either side numerous humorous instances were quoted, but the one advocate of the English system who excelled in this respect was Sir Frederick Bramwell, and many were the stories he told of the misplacement of the decimal points and consequent disaster. Among them was a report of the attempt a few years ago, in Brussels, upon the life of the present King, which, for this reason, gave the size of the bullet at something like twice as long as the barrel of an ordinary revolver. In the last bill which was put before Parliament on this subject, severe penalties were to follow upon the non-use of the system, but Professor Johnstone Stoney, who has given great thought to the matter, was totally against such a procedure. As a matter of fact, this gentleman himself has propounded a system whereby the existing units of the English system would be altered by such infinitesimal quantities to bring them into line with the provisions of the metric system that very little change would be needed, and this could be carried out with the minimum of inconvenience, especially to small tradesmen. Even the government, in the 1897 act, was assisted by Professor Johnstone Stoney, who spoke with great reasonableness and a great desire to minimize public inconvenience. Mr. B. H. Brough, the secretary of the Iron and Steel Institute here, said that probably the reason why the change over to the metric measures would be acceptable to the electrical industry was because that profession was more dependent upon German skill than mechanical engineering or any other. He also suggested that the reason why Germany would like to see the change was because the manufacturers there were already stocked with the new weights and measures ready to export to Great Britain.

Among other points raised against changing over was that Continental countries nearly all used Whitworth screw threads and not metric, and that the decimal points all produced great confusion. But, all things considered, the great weight of opinion seemed to be in favor of the change, and Mr. Siemens did well to point out that the decimal system was in existence long before the metric, and that the use of decimals was in order not to make too pronounced a change. A number of other speakers spoke on either side.

A variety of opinions was expressed as to the attitude adopted by the United States, but these seemed to cancel out, and left us where we were. Mr. Siemens stated that a change was viewed with favor, while Colonel Crompton, with "the latest information," said that if ever in any country there was a determination to stick to the inch it was in the United States.

As was not altogether unexpected, the Royal Commission on London traffic which has just been appointed, threatens to delay the passage of the tube railway bills this session. The work of the commission is most directly bound up in the question of underground railways and tramways, but no official decision has as yet been given on the matter, *i. e.*, whether all tramway and railway bills affecting London will be suspended, pending the report of the commission which can not reasonably be expected for some months, seeing that no sittings has yet been held. Mr. Yerkes has been very busy of late propounding the virtues of the twopenny-any-distance-fare, and has rather disgusted the steam railway companies, most of which have for some years carried workmen anywhere on their systems for that fare before a certain time in the morning. But, of course, Mr. Yerkes means that this fare should be universal throughout the day, and cites the five-cent fare in Chicago as a case in point. In connection with the "tube" railway bills which have been deposited for this session, a rumor is current that a late promotion is to be deposited for the construction of a line over identically the same route engineered last year by Messrs. Morgan, but which killed itself through a disagreement

between the partners. The London United Tramways Company has now gone quite over to Mr. Yerkes, who, by the way, has been made chairman of the company.

The influence which electric traction is exercising in Great Britain nowadays is exemplified in the south of London where the Battersea Polytechnic has initiated a department specially devoted to electric traction in which students, who wish to take up this branch of the electrical industry, may obtain a thorough training. A grant has been made by the technical education board, and special apparatus is being installed. The factors in this move on the part of the management are said to be the adoption of electricity on the London County Council tramways, and the rapidly increasing use of electrically-driven vehicles.

The General Electric Company (1900), Limited, has found it necessary to enlarge its existing works at Manchester, and consequently some 100 acres of land have been acquired near Birmingham which are chiefly devoted to the manufacture of dynamos and motors and, quite a novelty here in such a manufactory, a carbon factory. Of course the main building is the engineering works, which consists of two bays, each 340 feet long and 60 feet wide, attached to which are the offices. The machine tools are all arranged in groups of various classes, each under the supervision of a foreman who is a specialist in that class of work. Among the larger machines is a boring mill which will deal with a magnet wheel or armature frame over twenty-four feet in diameter, while the larger surface bed, which is seventy-five feet long and twenty-one feet wide, is equipped with two upright side-planing machines, a sixty-inch slotter, and other machines, all portable and driven by a separate electric motor. There are also a testing room, foundry and a factory for the manufacture of interior conduits. As regards the carbon factory, so little of this material is manufactured in Great Britain that the whole of the hands had to be trained by the company. All those difficulties were, however, quickly overcome, and the works are now in full running order, although there are yet a fairly large acreage for further extensions. In the power-house a continuous-current plant has been installed, chiefly because the present demand is for continuous-current motors rather than polyphase machines.

It does not speak well for the government's interest in scientific matters that a photometric department should have had to be added to the National Physical Laboratory at the expense of private benefactors. But such is actually the case. This department will soon be in working order now, and a long-standing complaint in respect to the want of legally standardized lamps will soon be removed. From the very commencement it was obvious that the government grant to the National Physical Laboratory was insufficient, and so it has proved. The recent discussion on Dr. Fleming's paper before the British Institution of Electrical Engineers on the photometry of electric lamps has created a stimulus in regard to this matter, which every one is agreed should have come earlier.

In another direction, too, the government is very chary of encouraging science, *viz.*, the Marconi wireless telegraph. A question has been put to the House of Commons as to when the public are to have the use of the system allowed to them, to which the Postmaster-General replied that "the effect of recent progress in the development of wireless telegraphy upon both the commercial and strategic interests of this country is now receiving the careful consideration of his Majesty's government. I am also in communication with the Marconi Wireless Telegraph Company upon the subject of its relation with the Post Office. I am not at present in the position to make any final statement on the subject, but I have no doubt it will be possible to secure for the public of this country the use of this method of communication when it is sufficiently developed for commercial purposes."

A. W.

London, England, March 7.

Electrometallurgical Problems.

This is the sixth and last article upon this subject by Mr. A. A. Beadle, in a London contemporary, the *Electrical Review,* and in it the author considers the problems presented in the electrometallurgical treatment of iron, tin, tungsten, nickel and cobalt, and mercury and antimony. Until lately electrometallurgy has been applied to iron for its deposition for the protection of electrotype plates. Harber states that pure iron can be deposited from its sulphate, but only at an exceedingly slow rate. Iron powder can be deposited from organic salts at suitable current densities, and this form a useful reducing agent. The smelting of iron and steel in the electric furnace has received much attention of late, and when carefully considered it can be seen that the possibility of its development is not remote. It is doubtful, however, whether electric smelting will ever take an important place in coal-bearing districts, though in combination with magnetic concentration in localities where water power is available and fuel scarce it may have a brighter future. Although the production of metallic tin from the mineral is a complicated branch of metallurgy, no serious attempts have ever been made to introduce electrical processes as there are serious difficulties in the way. The problem of recovering tin from iron scrap has been attacked at various times, but as yet no successful method is in use. A great difficulty in these processes is that only the surface tin—which amounts to but one per cent of the weight of the scrap—is removed, and that part which is alloyed with the iron is lost. The only important application of metallic tungsten is the alloy with steel, which generally contains about sixty to seventy per cent of metallic tungsten. The production of this alloy is an important problem, and it has been proposed to deposit it electrically into the molten iron used as cathode; but the practicability, as well as the advantages of this, seems doubtful. The complex metallurgy of nickel and cobalt is further complicated by the extreme difficulty in separating these two metals from each other. What is required is a method of fractionally electrolyzing a mixed solution of nickel, cobalt, copper and iron. Mercury is easily recovered from the sulphide by distillation. The method is injurious to those occupied at the works, and is wasteful. A process proposed consists of treating the ore with a solution of sodium sulphide and electrolyzing in iron vats. The mercury is extracted and the solution left ready for reuse. It is, however, doubtful whether this could be carried out commercially in practice. A metallurgical antimony is not difficult, but the commercial product is not pure. This contains most of the gold present in the original ore, amounting, sometimes, to several ounces of gold per ton of metal, and an electrolytic process which would recover this, at the same time producing pure antimony, might compete with the simple process in use to-day.

To determine what horse-power a shaft of a given diameter will transmit at a given number of revolutions per minute: Cube the diameter of the shaft; multiply the quantity by the number of revolutions per minute; divide this product by the constant number seventy-five; the quotient will be the horse-power. To determine the diameter of a shaft to transmit a given horse-power at a given number of revolutions per minute: Multiply the given horse-power by the constant number seventy-five; divide the product by the given number of revolutions per minute; extract the cube root of the quotient for the diameter of the shaft.

The Annual Report of the New York & New Jersey Telephone Company.

The twentieth annual report of the directors of the New York & New Jersey Telephone Company shows that the gross earnings were $3,962,597.06. The expenses of operation were $2,823,457.55, the earnings over expenses of operation amounting to $1,139,051. A comparison shows the gross earnings in 1902 to have been $3,962,597.06, as against $3,376,432.89 in 1901, an increase of $586,164.17. The increase in the earnings over expenses was $57,339.79.

The early part of the year 1902 was a season of unusually destructive storms, which, for a considerable period, seriously crippled all overhead telegraph and telephone lines in the territory operated by this company, and entailed heavy expenditures for repairs and replacement of the destroyed plant.

The disastrous conflagration which swept over the business section of the city of Paterson, N. J., on February 9, 1902, was followed on March 2 by an overflow of the Passaic River, which completely flooded the lower part of the city, causing loss of life and great damage to property.

Fortunately, the company's building, lately completed, was situated outside of the devastated district, but a considerable amount of the plant in the streets was destroyed or seriously damaged, causing some interruption to service of local subscribers. On the night of February 21, 1902, the territory was visited by the most destructive sleet-storm in the history of the company, the overhead lines of this company, as well as those of the telegraph, electric light and railway systems, being almost completely prostrated. In the large near-by cities the damage was much lessened by the predominance of underground lines. While every effort was being put forth to secure an early restoration of the crippled plant, substantially the whole force of linemen left the service without intimation of dissatisfaction on their part. This added greatly to the difficulty and delay in the restoration of the service, and to some extent increased the cost of the work. The actual cost of repairing and rebuilding the prostrated lines was $267,505.05, and the loss of revenue through the interruption of service is estimated at about $100,000. The entire cost of repairs has been charged against the earnings of the year. Under normal conditions, the net earnings for the year 1902 should have been at least $365,000 above the amount earned.

Through the use of the underground trunk line leading from Jersey City to Newark, the company was enabled to furnish to its patrons uninterrupted communication between New York and Brooklyn, Jersey City and Newark, during the time when other lines were disabled.

During the summer an experimental installation of the Pupin invention was made upon this line with most encouraging results. The trunk line conduit has now been extended from Newark to Elizabeth, and further large extensions have been planned, to reach Passaic and Paterson, in New Jersey, east to Jamaica, in the Long Island division.

In cooperation with the New York Telephone Company, comprehensive plans have been worked out by which all of the suburban points within a radius of twenty miles of New York will be connected through underground cables, thus protecting the entire suburban toll service against interruption through unfavorable weather conditions. These plans contemplate the equipment of all central offices within this radius with the common battery system.

The company purchased during the year the plant and business of the Hudson River Telephone Company, in Sussex County, N. J., and among the important improvements completed in 1902 was the conversion of the exchange plant in Elizabeth, N. J., from overhead to a complete underground system. The company's central offices at the Hamilton and South exchanges have been enlarged, a new building completed at East New York, and improved central office apparatus installed at each of the above exchanges. New buildings are under construction for exchanges at Prospect and Bay Ridge, Brooklyn, and Brick Church, N. J., at which point it is proposed to consolidate the business of Orange and East Orange, heretofore operated separately.

Sites have been purchased upon which buildings are to be commenced during 1903, for central offices at Greenpoint and Flatbush, Booklyn; Tompkinsville, Staten Island, and Long Branch, N. J. Enlargement of the Jersey City building has been found necessary, and is now under way.

There was invested by the company during 1902, $1,712,502.25 for extension of plant and equipment, and $239,285.23 for real estate. Of the amount invested in the plant, $821,561.25 was expended in extension of the underground and cable system. There were, on January 1, 1903, 25,026 stations in the Long Island division, and 28,158 in the New Jersey division, making a total of 53,184.

The death of Mr. Felix Campbell, a director of the company, occurred in November. At a special meeting of the board of directors, held for the purpose, resolutions of sympathy were adopted.

The report is signed by Charles F. Cutler, president, who pays a tribute to the employés who remained faithful to the company during the trying times caused by the unprecedented storm in February, and the other difficulties which were encountered.

The officers of the New York & New Jersey Telephone Company are as follows:

President, Charles F. Cutler.
Vice-president, W. D. Sargent.
Secretary, Waldron Hoppins.
Treasurer, Henry Sanger Snow.
General manager, J. C. Reilly.

The Independent Telephone Association of Maine.

This association was organized in October, 1901, with Mr. M. S. Bird, of the Eastern Telephone Company, of Rockland, Me., as its president, interconnecting contracts having been made by the Eastern company with many of the rural and village exchange lines. A short time after these contracts were executed, the Eastern company merged its interests with the New England Telephone and Telegraph Company. This action provoked considerable friction among the independent interests of this section.

At the recent meeting of the Independent Telephone Association of Maine, Mr. Lewis A. Goudy, vice-president and general manager of the Northeastern Telephone Company, of Portland, Me., was elected president. Officers were also elected as follows: First vice-president, R. L. Cummings, Citizens' Telephone Company, South Paris; second vice-president, P. C. Chandler, Pine Tree Telephone Company, New Gloucester; secretary, E. L. Durgan, Northeastern Telephone Company, Portland; treasurer, F. L. Wyman, West Paris & Curtis Hill Telephone Company, West Paris; Executive committee: B. G. McIntyre, Waterford; John H. True, New Gloucester; Dr. F. H. Packard, West Paris; E. W. Gross, Auburn; E. L. Tibbetts, Lewiston; George H. Jones, Oxford, and H. A. Cook, Casco.

CORRESPONDENCE.

Engineering Data.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I wish to recommend strongly that you advocate in your journal that all central station data as to fuel consumption, kilowatt-hour output, etc., hereafter include "the pounds of water evaporated" and stating the pressure (or temperature) to which same is raised, and, if it is desired to be very exact, also stating the temperature of water before it enters heater or boiler.

In considering recently the results obtained in various stations and powerhouses, I found it extremely difficult to compare them with each other with a view to ascertaining the economy of operation due largely to the difference in quality and price of coal, and, in some instances, to the boilers, firing heaters, etc. As all of these variable items are eliminated by using as a basis the pounds of water evaporated from a given temperature to another given temperature, and the station showing is thus divided into two parts—one the economy and cost of evaporation, the other the economy and cost of generation—we think the evaporation should hereafter always be included as data absolutely necessary if a comparison is to be made with other stations.

On this basis, the pounds of water evaporated per kilowatt-hour output of the station is a factor permitting the direct comparison of stations using the cheapest and best fuel obtainable with stations using the poorest and dearest fuel, and by taking into consideration the load curve and class of machinery equipment, it can readily be determined whether or not a station is operating economically, and the total economy of systems employing different methods of distribution, alternating current and direct current, rotary converters and motor-generators, also with and without storage batteries, can be determined, and a comparison made on a reliable basis.

JOSEPH E. LOCKWOOD, President,
Michigan Electric Company.

Detroit, March 6.

The Ferraris-Tesla Inventions.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

The news statements in the daily papers in respect to the recently decided Tesla litigation do not state the facts inasmuch as they allege that the United States Court "in one circuit upholds his (Tesla's) patents, and in another does not." Thursday's decision by Judge Colt in Boston, corroborating a prior decision by the United States Court of Appeals (Judges Townsend, Wallace and Cox), after a most exhaustive and thorough trial, lasting four years, decides that Mr. Tesla failed to prove invention prior to the published description of the same invention made by Professor Ferraris, of Turin, Italy. Professor Galileo Ferraris held the chair of physics at the Academy of Sciences in Turin for many years. In Europe he is universally acknowledged to be the original inventor of the induction motor and power transmission system, so largely used in this country, which is attributed by the news statements referred to as "one of the greatest inventions of any age." All foreign scientific publications speak of the Ferraris motor, the Ferraris principle and the Ferraris system, for he invented, constructed and described his work several years before Mr. Tesla claims to have devised it. So fully and completely is this fact accepted by scientific men that a public subscription has been taken up in Europe (now completed) for the erection of a suitable statue to Ferraris in Turin. I myself have seen the original motors, models and drawings made by Ferraris in 1885, have personally talked with the men who saw these models in operation and heard Ferraris explain them at that date.

As for the Tesla meter mentioned, so far as I am aware Mr. Tesla does not claim to have invented a meter, nor has he any patents for a meter.

WILLIAM STANLEY.

Great Barrington, Mass., March 16.

Philadelphia Branch of the American Institute of Electrical Engineers.

The first regular meeting of the Philadelphia branch of the American Institute of Electrical Engineers was held at the Engineers Club, 1122 Girard street, Monday evening, March 9.

There was a short business session during which Mr. Carl Hering was elected chairman, Mr. H. F. Sanville, secretary, and Messrs. Charles Hewitt, W. C. L. Eglin J. F. Stevens, H. A. Foster and Theodore Spencer members of the executive committee.

Mr. W. L. Bliss then presented his paper on "Railroad Train Lighting," and Mr. W. C. L. Eglin presented abstracts of the papers of Messrs. Farnsworth and Sperry, on the same subject.

A discussion was opened by Dr. C. B. Dudley, of the Pennsylvania Railroad Company, and carried on by Messrs. W. L. Bliss, Hugh Lesley, C. J. Reed, Spalding, J. B. Klumpp and others.

The meeting was well attended. Representatives of all the large steam railroads running through Philadelphia were present.

The next meeting of this branch will be held on Monday night, April 6.

The Chicago Branch of the American Institute of Electrical Engineers.

The Chicago branch of the American Institute of Electrical Engineers has issued the following schedule for the spring programme of 1903: On March 24 there will be a special local meeting to consider the subject of "The Chicago Transportation Problem." This will be a joint meeting of the American Institute of Electrical Engineers and the Western Society of Engineers. A résumé by Mr. Bion J. Arnold of his recent report to the city council on the Chicago transportation problem will be presented at this meeting. This will be illustrated by lantern slides. In order that the members of both societies may invite their friends, this meeting will be held in Fullerton Hall, Art Institute, Michigan avenue and Adams street.

On April 7 the topic will be "High-Tension Lines." The papers scheduled are as follows: "Mechanical Specifications for Proposed Standard Insulator Pin," by Ralph D. Mershon; "The Testing of Insulators," by F. O. Blackwell; "Transposition and Relative Location of Power and Telephone Wires," by Paul N. Lincoln; "Burning of Wooden Pins on High-Tension Transmission Lines," by C. C. Chesney.

On May 5 the subject will be "Tendencies of Central Station Development," the following papers being scheduled: "Economical and Safe Limits in Size of Central Stations," by H. A. Lardner; "Safety Devices in Central Stations and Substations," by Phillip Torchio, and "Multiple *Versus* Independent Operation of Units and Central Stations," by Peter Junkersfeld.

On May 19 a special programme of papers and discussions by local telephone experts is to be presented, the preparation going on under the direction of Mr. Kempster B. Miller and Angus S. Hibbard.

These three meetings will be held at the rooms of the Western Society of Engineers, Monadnock Building.

The officers of the Chicago branch are: George A. Damon, chairman, and R. H. Pierce, secretary. The executive committee is as follows: James Lyman, Peter Junkersfeld, H. H. Wait, Angus S. Hibbard, Kempster B. Miller and J. R. Cravath.

BOOK REVIEWS.

"Précis d'Électrochemie et d'Électrométallurgie." ("Compendium of Electrochemistry and Electrometallurgy.") By Leon Guillet. Paris. J. B. Baillière et Fils. Cloth. 364 pages. 5 by 7 inches. Numerous illustrations.

This book gives brief reviews of recent methods in applied electrochemistry and electrometallurgy, with descriptions of the apparatus. The subject is divided into four sections—electrolysis proper, the electric furnace using the Voltaic arc, the ozone industry using electrical discharges, and the electric spark.

After a brief introduction, in which units and formulæ in use are given, the first division of the book takes up the production of hydrogen, oxygen, chlorine, caustic soda and other derivatives of metal ores; the electrolytic purification and the production of metals—copper, zinc, silver, gold, lead, etc.—and the production of organic compounds. The second division describes the various types of electric furnace, both the commercial and laboratory types. The aluminum industry is discussed at some length. In the third part the various types of apparatus for producing ozone are described, and the application of this substance is discussed. Nothing is said of the applications of the electric spark. The book concludes with a summary of the electrochemical plants in France.

"Conductors for Electrical Distribution." F. A. C. Perrine. New York. D. Van Nostrand Company. Cloth. 287 pages. 6½ by 9½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $3.50.

In this book Dr. Perrine has brought together a great deal of valuable information covering the subject of electrical conductors very completely. The first chapters discuss conductor materials, mechanical and electrical data, temperature effects, and carrying capacities for conductors of all kinds. Four chapters are devoted to the manufacture of wire and cables. In these the process is followed from the ingot to the finished product. This section of the book will be very instructive to engineers and students, for the study of the manufacture is something that is generally neglected, and few electrical men who are not connected with a wire factory know much of this important art. Here we may follow the wire through the various rolling mills—drawing, annealing, finishing, the application of insulating coverings of various kinds, and, in the case of cables, to the laying together of the separate wires and applying final protective coverings. The preparation of the insulating materials is also thoroughly explained. The calculation of circuits is then taken up. In this part of the book the use of wiring tables and calculators of various kinds is described. The Kelvin law of economy in conductors is deduced and its application shown. The laying out of distributing circuits to the best advantage is considered. Chapter X gives an excellent discussion of alternating-current line calculation, both analytically and graphically. In this the effect of the constants of the receiving and generating apparatus is taken into consideration. The remainder of the book discusses line location, line construction and line material. This section includes a great deal of very practical information, such as wind strains on wires, constants for tensions and length of spans, etc. In the last chapter the various systems of laying conductors underground are described and the requirements of this class of work pointed out. The book is accompanied by five plates for use in line calculation. It is one of the most complete books upon electrical conductors that has yet been published, and will certainly be of great assistance to the electrical engineer as well as to the student.

Mexico and Electricity.

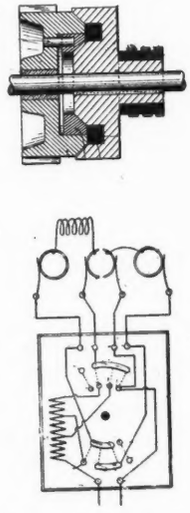
"The use of electricity, not only for lighting but also for industrial purposes, is," says an official of the British Legation at the City of Mexico, in a report made to the British Foreign Office on Mexican trade in 1901, "becoming more general, and several companies have been formed for the purpose of making use of the larger waterfalls throughout the country for the generation of electricity, the machinery being imported chiefly from the United States. The Electric Light Company of the City of Mexico has been unable to supply the demand for electricity for lighting purposes, and the extension of the electric tramway lines about the City of Mexico has greatly increased the use of electricity."

Journal of the Western Society of Engineers.

The February number of the *Journal* of the Western Society of Engineers contains an article by Mr. J. F. Jackson, on "Copper Mining in Michigan," and a study of "The Diversity of Practice in General Railway Engineering on American Railways," by Mr. A. A. Schenck. Mr. Elwood Mead discusses "The Administration of Streams Used in Irrigation." This issue also contains the reports of the annual meeting.

Electrical Patents.

Mr. Edwin R. Douglas, of East Orange, N. J., has patented a novel magnetic clutch and has assigned his entire interest in the patent to the Crocker-Wheeler Company, of Ampere, N. J. The invention relates to electromagnetic clutches in which the engagement and disengagement of the members are controlled by the magnetic action induced by an electric current. The object of the invention is to produce a clutch of this class which shall be simple and efficient in its construction and operation, which shall automatically adjust its friction surfaces to meet the varying conditions produced by wear, and one which shall be more certain in its engagement and disengagement than those heretofore in use. The invention consists in providing means for causing an electric current to magnetize a clutch body to throw the clutch into action, and means for rapidly demag-

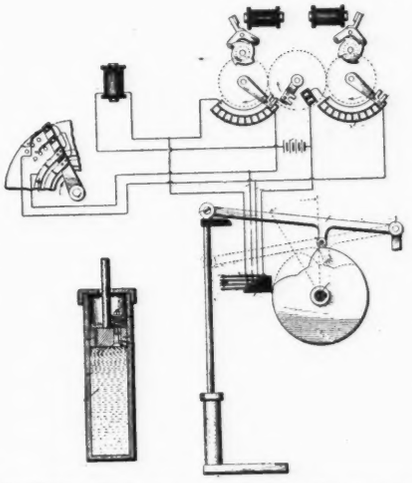


MAGNETIC CLUTCH.

netizing the same to throw the clutch out of action, and in providing means whereby the two poles of the armature engage the corresponding poles in the main body portion without interfering with each other and without interfering with the magnetic circuit. Clutches of this kind usually consist of two or more rotatable members, either mounted on the same shaft or on different shafts having a common axis of rotation. One of these members is usually fixed to the shaft and the others are free to turn relative thereto except when the members are in engagement with each other. One of the members is provided with a coil of insulated wire adapted to receive an electric current to magnetize it, and this member may be referred to as the "main body." The other member, which coacts with the main

body and, when in engagement, completes the magnetic circuit, can be termed the "armature." Both the main body and the armature are made of iron. It is well known that if the iron armature be allowed to make actual contact without the intervention of a non-magnetic material, such as fibre or brass, the driving force will be a maximum, because the reluctance of the magnetic circuit will be thereby reduced to a minimum; but it is also well known that if this be done, the clutch will not readily disengage when the current is interrupted, as the residual magnetism is sufficient to hold the armature against the main body with considerable force. To cause immediate disengagement when the current is interrupted, various means have been employed, as by increasing the reluctance of the magnetic circuit by a small amount of non-magnetic material interposed somewhere in the magnetic circuit, either between the poles of the armature or of the main body or at some other point. These devices, while assisting disengagement, have the disadvantage that they greatly weaken the driving power of the clutch, or, what amounts to the same thing, require a great deal more energy to be expended in the magnetizing coil to give the same driving force, requiring a much larger coil and making the clutch more bulky. A clutch constructed in this manner, with a magnetic circuit interrupted as above indicated, may require ten times as much current as would otherwise be needed to produce the same driving force. In this invention a magnetic clutch is provided which will immediately disengage when the current is interrupted, and at the same time requires no non-magnetic material to be inserted in its magnetic circuit. The contact surfaces of clutches of this character are usually annular in form, one pole or ring lying within the other and being of smaller diameter. The result is that the effective turning moment of the outer ring or pole is much greater than that of the inner, provided the pressure is equally great; but, as the wear of the outer ring or pole is also greater, the result is that after the clutch has been in use for a considerable period the greater pressure is taken up by the inner pole, and thus the efficiency of the clutch is materially reduced. In the improved clutch the poles are so constructed that neither pole interferes with the action of the other, each pole, regardless of wear, exerting its full pressure when the current is on.

Trouble-testing apparatus for telephone systems has recently been patented by Mr. Frank Reeves, of New York city, and is controlled by the Electromechanical Improvement Company, of Charleston, W. Va. The invention relates to improvements in automatic means for indicating the occurrence of electrical or other trouble in the operation of automatic telephone systems, and has for its primary object the prevention of delay or interruptions in such systems by the immediate notification of the switchboard attendant of the presence of such trouble either in the exchange or on the line. It is especially applicable to those automatic systems in which all the switching operations at central are controlled or operated by a single power device, and is designed with especial reference to a system patented by Mr. Ernest A. Faller in



TROUBLE TEST FOR AUTOMATIC TELEPHONE SYSTEMS.

1901. In the system shown in the above-mentioned patent each successful switch is accompanied by or depends upon one complete revolution of a so-called "master-shaft." When the system is in order, each revolution of this master-shaft is completed in a predetermined length of time and no longer. This revolution of the said shaft, however, is not continuous, but its motion is interrupted once and resumed again. The whole cycle, though, occupies a predetermined period, as above stated. Should any trouble occur to prevent a complete switch from being effected or should anything happen to prevent this master-shaft from making its revolution in the prescribed time, including its failure to start again after its usual momentary stop, the delay will cause the operation of a signal which will notify the attendant of the occurrence of trouble. In the present invention the selector wires of the system are tapped by four wires, which are connected to an equal number of contact springs constituting an emergency contact device, the springs being mounted upon a rigid insulating support. Means are provided which, in case of trouble, will bring the contacts into proper engagement and thereby complete the circuit through the coils of a restarting magnet and at the same time sound a call in the central station. This operating means comprises, among other parts, a lever of the second order, provided with an intermediately disposed roller which rests upon the periphery of a rotating cam. Pivoted to the power end of the lever is a depending rod, which is secured at its lower end to the piston of a dash-pot. The dash-pot consists of a cylindrical casing containing the valve piston and a quantity of oil or other liquids. By this arrangement, the downward motion of the piston is retarded, while its upward motion may be much more rapid. A trigger of insulating material is mounted fast on the rod, and is so located that when the piston descends to a predetermined extent the contact springs will be engaged thereby and the trouble circuit completed. According to the structure originally patented, the master-shaft is started and stopped twice for each cycle of operations to perform a complete switch. By the first portion of its revolution the calling shuttle is dropped—that is to say, the line terminals of the calling subscriber are placed in the first preparatory or selective position before actually connecting them to the loop circuit. The second part of the revolution of said master-shaft causes the dropping of the called subscriber's shuttle and the completion of the switch, including the actuating of the ringer mechanism. The operation of the improved apparatus is as follows: When a call is sent in to the exchange, the master-shaft rotates through an arc of about thirty degrees, then stops momentarily and starts up again, rotating continuously through the remaining 330 degrees, after which it again stops until the next call is sent in. The cam will likewise be rotated and the lever will immediately commence to descend, but owing to the resistance offered by the dash-pot this descent is necessarily very slow. If the system is in good working order the pause of the cam at the end of the first thirty degrees will not be of sufficient duration to allow the lever to descend to any appreciable extent. If, however, owing to any one of many causes, the cam does not rotate in the prescribed time, or if it fails completely to start after making its first stop, this will give the lever time to descend to such an extent that the trigger carried by the rod will engage the spring of the emergency contact device, bring it into engagement with the adjacent spring and thus close the circuits.

Reviews of Current Engineering and Scientific Literature.

The Ramassot Surface Contact Railway System.

This is a description by Mr. A. Bainville of a new surface contact system which does not differ very essentially from others of this class. It is comparatively simple in construction and operation. Contact blocks are laid between the rails, about fifteen feet apart. This contact consists of a metallic block sunk in a large block of some insulating material. A cable runs to the contact block from the automatic switch. This switch consists of a solenoid and a movable iron core. To the core are attached carbon contact pieces, which close the circuit from the feeder to the contact block through the cable just mentioned when the core is drawn up. The coil is formed of three windings. One is of fine wire, through which a current is passed from a small commutator on the car in order to close the switch, and which winding is short-circuited as soon as the switch is closed. The second winding consists of heavy wire through which the current passes to the motors, and which holds the switch closed until the car has passed. The third winding has a comparatively high resistance, and when the switch is closed current passes through this to keep the batteries on the car charged. These automatic switches are grouped in a cast-iron box about every 300 feet. Current is collected by a contact shoe on the car of sufficient length to span the distance between two contact blocks. The rails are used as the return circuit. The battery required on each car is quite small, and it is only used in starting the car. Tests which have been made of this system have given very satisfactory results.—*Abstracted and translated from l'Electricien (Paris), February* 28.

Electric Wiring.

This paper gives the discussions which took place recently at a meeting of the Glasgow section of the British Institution of Electrical Engineers. This was opened by Mr. W. A. Chamen, who stated that one of the most fruitful causes of trouble seems to be the improper use of metal-sheathed tubing with slip joints. Fires have frequently been caused or started by joints of this kind, the tubing and joints being merely threaded on the wire. Frequently, no precautions were taken to prevent sharp edges of the tubing from cutting through the insulation on the wire. When a fire occurred it was usually found that at some point one of the lengths of the tube had become alive through cutting of the insulation in this way, and was, at the same time, in contact with a gas pipe. This caused an arc which burned a hole through the gas pipe and ignited the gas, the gas eventually setting fire to the surroundings. He thought that the only way to correct this was to use a threaded joint, which could only be installed by an expert workman. It is impossible to prevent gas pipes and electric conduits from coming in contact at some point of the building, and the proper location of the two systems requires the working together of the two contractors. He thought that before long both the installation of gas pipes and electric wiring would be carried out by the same contractor. He also thought that wooden moulding was the most dangerous method of installing wires, but the fact nevertheless remained that fires resulting from this method of installation were less frequent than from other causes, and he attributed this to the fact that the work was done carefully by expert carpenters. Mr. E. G. Tidd emphasized the necessity for continuous metallic conduit, thoroughly grounded. He thought it would be desirable to have a requirement stating the maximum resistance which would be allowed between any point of the metallic conduit and the earth. The tests for this resistance should be made at a number of points in the installation. He objected to the practice of insulating chandeliers from the gas pipes. Mr. H. A. Mavor called attention to the increasing risk, due to the more general use of motors, which require conductors carrying very heavy currents.—*Abstracted from the Electrical Review (London), February* 20.

The Effect of Changes of Temperature on Permanent Magnets.

In this article Mr. H. B. Loomis describes his investigations upon the effect of temperature on permanent magnets. The first part of the article gives an historical sketch of previous work. His own work is divided into two sections—first, to determine the relative change of the magnetic moment of magnets of different length, but of the same cross-section; second, to determine the change in distribution due to change in temperature. Work on the first problem was carried out by suspending small permanent magnets made from the same material, of different lengths, within a carefully constructed box which could be kept at the desired temperature. The magnetic moment was then found by determining the period of each magnet. This was done with the various samples at different temperatures. The results show that the proportional change in magnetic moment, due to change in temperature, is greater for short than for long magnets, and that a magnet having a greater intensity of magnetization suffers less proportional change. The second part of the work was carried out by a specially constructed apparatus suggested by the late Professor Henry A. Rowland. Two small permanent magnets were connected rigidly together by a brass rod. Over each of these were slipped two small fine wire coils, the four coils being attached to a light brass rod so that they all moved simultaneously. A stop arrangement allowed the coils to be moved step by step over the whole length of the magnets. Readings were taken by connecting these coils to a suitable galvanometer, and the absolute value of the flux cut during each movement was found by comparison with an earth coil. This series of experiments shows that the proportional change in distribution of the magnetism, due to change in temperature, is greatest at the ends, and least in the middle of the magnet. These results differ from those found by earlier observers, but it is thought the method is more accurate, and hence the results more reliable. An explanation is suggested, based on Ewing's addition to Webber's theory of magnetism, which assumes that the forces which hold the little molecular magnets in position are largely the mutual attractions and repulsions of these molecular magnets among themselves. It follows from this assumption that the forces acting upon the magnets at the extremity of the rod will be less than those nearer the centre, and hence disturbances due to change in temperature will be more pronounced there.—*Abstracted from the American Journal of Science (New Haven), March.*

Side Poles for Electric Tramways.

Mr. G. G. Braid here gives a comprehensive analytical study of side poles for electric tramways. Three classes of poles are considered—straight, tapered and

three-section. Examples are given to illustrate the use of the formulæ deduced, and tests have been made which verify the results obtained by calculation. Comparing the tapered form of pole with the parallel pole, and the one built up of three parallel sections, various relations as regards strength, stiffness and weight are obtained. Comparing a tapered pole with one having parallel sides, there are three conditions possible—the two poles may be equally strong, they may be equally stiff, or they may be equally heavy. Assuming a thirty-foot pole in each case, the metal one-half inch thick, and the pole sunk to a depth of six feet in the ground, with a force of 1,000 pounds acting on the pole at a distance of four feet from the top, the results are given in the following table:

	Tapered Pole.					Parallel Pole.				Pole in Three Sections.							
	Maximum Stress. Lb.	Deflection at Top. In.	Weight. Lb.	D. In.	*d.* In.	Maximum Stress. Lb.	Deflection at Top. In.	Weight. Lb.	D. In.	Maximum Stress. Lb.	Deflection at Top. In.	Weight. Lb.	D_3 In.	D_2 In.	D_1 In.	l_2 In.	l_1 In.
Equal strength.....	892.6	3.176	1,000	9	3	892.6	1.71	1,360	9	892.6	2.39	1,285	9	8	7	186	139
Equal stiffness.....	892.6	3.17	1,000	9	3	1,367	3.176	1,106	7.41	1,080	3.176	1,159	8.25	7.25	6.25	181	130
Equal weight..	892.6	3.176	1,000	9	3	1,679	4.281	1,000	6.75	1,410	4.736	1,000	7.3	6.3	5.3	173	117

In this table, under the head of "tapered pole," D is the diameter of the pole at the ground line; *d*, the diameter at the top. Under "pole in three sections," D_3, D_2 and D_1 are the diameters of the three sections of pole, and l_1 is the vertical distance from the point of attachment of the span wire to the top of the second section of the pole, l_2 being the vertical distance from the point of attachment of the span wire to the top of the bottom section of the pole.—*Abstracted from the Electrical Engineer (London), February 27.*

A System for Distributing Electrical Energy.

In order to employ continuous currents for the distribution of electrical energy, substations where accumulator sets are installed may be employed. These stations are connected in series in the high potential circuit, and they may be entirely or partially disconnected from this circuit while they are discharging into the distributing system. A transformation of potential is thus secured without difficulty, but in order to avoid danger from the high-potential circuit and to avoid the expense of insulating all the circuits for the maximum potential, it is advisable to disconnect the batteries from the high-potential circuit while they are connected to the low-potential circuit. This may be accomplished by installing two battery sets. A suitable arrangement of switches enables these to be connected to the distributing circuits or to the high-potential circuit for charging. To avoid opening either circuit while this is being done, and yet at no moment to throw the high potential on to the local circuit, a circuit containing a resistance and connected in shunt to the two batteries should be provided. The operation then may be as follows: Let one battery be charging while the other is discharging to supply the local needs. By connecting the shunt resistance in parallel with the charging battery, and then throwing the latter in parallel with the discharging set, the charged cells can be added to those already in use; then by connecting the exhausted set to the charging circuit, and opening the shunt resistance, a transfer will have been effected without in any way interfering with the operation of either the high-potential or the low-potential circuits. If desirable, a reserve battery may be substituted for the shunt resistance, and thus avoid a loss of energy. The exchange of batteries can take place as frequently as is desired, and may be done automatically. For this reason the capacity of the batteries needs to be only great enough to carry the charging current without injury, and can be independent of the local requirements. Each substation operates unaffected by any other. No discussion is given of the means of preventing losses due to overcharging of cells in a substation supplying a section where the demand is small, nor is it explained how substations supplying districts where the demand is large can be kept charged.—*Abstracted and translated from the Elektrotechnische Anzeiger (Berlin), February 12.*

Electrolytic Decomposition for the Cologne Accumulator Works.

Herr Gottfried Hagin here discusses the advantages of the oxyhydrogen flame obtained from electrolytic hydrogen and oxygen, as compared with the blow-pipe, using illuminating gas, in storage battery factories, and for use when installing a battery plant. The great advantage of the oxyhydrogen flame is, of course, the exceedingly high temperature obtainable, which not only shortens the time required in any piece of work materially, but permits larger joints to be made. The gases required for this work are easily procurable, and can be shipped conveniently for use at distant points. The Cologne accumulator works has been operating an electrolytic plant for producing hydrogen, and after one year's experience has found the installation of this plant entirely satisfactory and economical. Of the many types of cell which can be used for this purpose, the company has decided upon one using sulphuric acid as the electrolyte, and having no diaphragm. It is, of course, very important to prevent mixing of the two gases, and diaphragms which have been used for this purpose are more or less expensive, and have but short life. They have adopted electrodes constructed of lead pipes, coated with an insulating covering on the outside. The gases set free by electrolysis then rise up within the electrode and are carried off through suitable pipes to the receiver. The pressure is secured by a water column. The electrolyte has a specific gravity of 1.23, and the potential required varies from 3.3 volts per cell to 3.6 volts per cell. When a circuit of 110 volts is available, thirty cells are connected in series, all feeding into the same pipes, connections being made to these through insulating couplings of rubber tubing. The output per horse-power-hour is 97.5 litres of hydrogen, and one-half this of oxygen. The cost of electrical energy is four pfennigs (one cent) per horse-power-hour. The cost per cubic metre of the mixed gases is then about eighteen pfennigs (four and one-half cents). The purity of the oxygen is ninety-nine per cent, the remaining one per cent consisting of water vapor and hydrogen. The apparatus required is simple, and the electrical equipment consists of but an ammeter and voltmeter and a switch. There is no danger of explosion and no diaphragms to renew. There is, however, a loss of energy due to the greater counter-electromotive force set up by the lead electrodes as against carbon or other non-oxidizable material.—*Abstracted and translated from the Centralblatt für Accumulatoren (Berlin), February 15.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A New Linotype Motor.

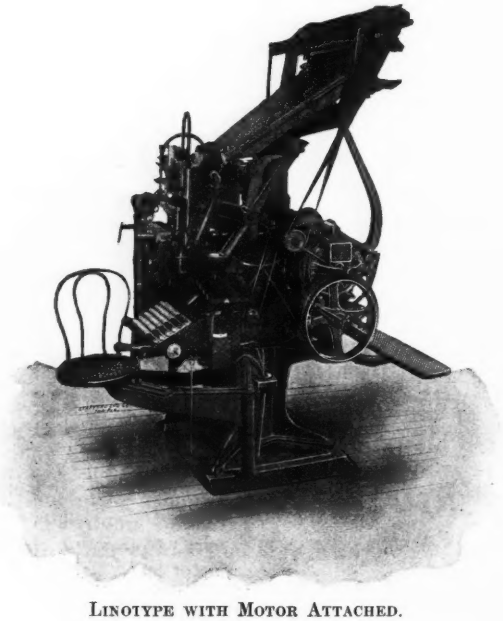
This motor is of the multipolar, semi-enclosed type, the field frame being cylindrical, with an ornamental ventilated front head. The bearings are of phosphor-bronze, with ample wearing surface, and are self-oiling. The brushes are of

A NEW LINOTYPE MOTOR.

carbon, and bear on the commutator, which has radial bars flush with the front head. The armature is made up of form-wound coils on the toothed laminated core. The coils are carefully insulated with high-grade material.

These motors are furnished wound for any pressure up to 250 volts direct current.

The bronze pinion on the motor shaft



LINOTYPE WITH MOTOR ATTACHED.

and the clutch gear-wheel, which is provided with the motor to mount on the Linotype, have cut teeth, and, to ensure safety, are protected by a substantial guard. The gear and pinion are carefully cut to ensure perfect meshing and noiseless running. Substantial oil ducts are provided for convenience in oiling the back bearing, and to carry off any overflow from the oil reservoir. A speed regulating switch on top of the motor is covered by a polished brass cap, and the brushes and terminals are covered by the ornamental name-plate. In this way all current-carrying parts are protected.

Two projecting lugs on the back of the motor frame are drilled to receive bolts, which hold the motor rigidly in place on the Linotype frame. These bolts are the ones that hold the cap on the main bearings of the Linotype, and longer ones to take the place of those on the Linotype are furnished with the motor. The clutch gear-wheel which replaces the drive pulley is fitted with a bushing which is bored to fit the main drive shaft. With this construction it is only necessary to fit the gear with a new bushing in case of wear on either the gear or shaft, saving the expense of an entirely new gear.

This is also an advantage in mounting the motor on an old Linotype, where the shaft has been worn down below the standard diameter.

The standard windings provide for a minimum speed on the Linotype of sixty-three revolutions per minute. By means of an auxiliary field winding, with five connections to a terminal board on top of the motor, this speed may be increased to about seventy revolutions, with three intermediate speeds. This arrangement allows the operator to adjust the speed to suit conditions.

These motors are made by the Jenney Electric Manufacturing Company, of Indianapolis, Ind.

The Philippines Electric Railway, Light and Power Plant.

A cablegram has been received by the War Department, at Washington, from Governor Taft to the following effect:

The Municipal Board of Manila, the Advisory Board and the Philippine Commission, acting jointly, have accepted the bid of Charles M. Swift, of Detroit, for railway and electric light and power franchises in the city of Manila. First-class fares six cents, 100 tickets for $5.50. Second-class fares five cents, six tickets for twenty-four cents. Mr. Swift represents a syndicate comprising himself, J. G. White Company, engineer and contractor, of 29 Broadway, New York; Frank H. Buhl and P. H. Kimberly, of Sharon, Pa., and George C. Smith, of Pittsburg, representing the interests of the Westinghouse Electrical and Manufacturing Company.

The above syndicate will immediately form a company to take over this concession which covers the building of thirty-five miles of electric railway in Manila and its suburbs, and the building and operation of electric light, heat and power plants.

The above syndicate has also contracted to purchase the old Manila tramways, and will thereby have control of all the tramway business in the city of Manila, which has a population of something over 300,000. J. G. White & Company will have the entire construction of both the railway and lighting plants, as well as the track construction, overhead trolley system, etc. The Westinghouse companies will furnish the apparatus.

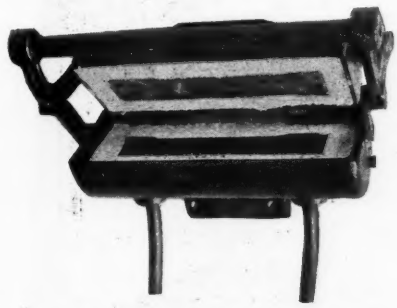
It is stated that the Philippine Commission is pleased with the entire transaction and regards it as the beginning of a new epoch in the Philippines in the investment of large American capital, and also feels convinced that the franchise granted by them to the above syndicate will be both beneficial to the people in Manila and also to the investors.

The engineering plans for the construction are now under way, and en-

gineers will start in the near future for Manila to begin their work so that no delay will occur. It is probable that the greater part of the material used will be shipped from America at an early date.

The Protection of Street Car Motors.

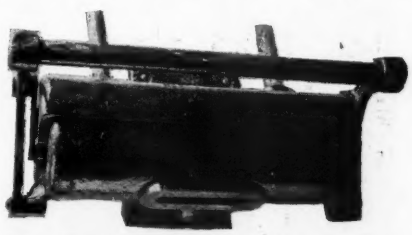
Perhaps the best appliance for protecting a street-car equipment from too great



FUSE BLOCK FOR ELECTRIC STREET CAR—OPEN.

overloads is the automatic circuit-breaker, serving, also, as a canopy switch when installed within easy reach of the motorman. The great advantage of this arrangement is that it is easily accessible, can be quickly closed and is in no way dangerous, thus avoiding the usual delay and risk incident to replacing a fuse.

Where it is not thought advisable to incur the expense of equipping all the cars of a line with automatic circuit-breakers, the next best thing is a fuse block possessing the same qualities of

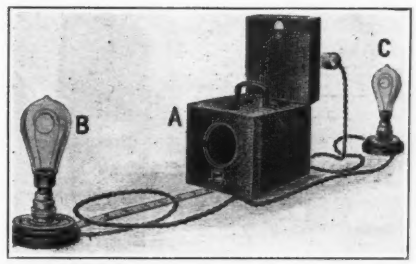


FUSE BLOCK FOR ELECTRIC STREET CAR—CLOSED.

easy accessibility, replaceability and freedom from danger. The fuse block shown in the accompanying illustration can be easily got at for renewing the fuse and, when open, the contacts on which the fuse is supported are cut out of the circuit, making it perfectly safe to replace the fuse while the line is alive. A straight piece of copper wire is used as a fuse and is secured in place and clamped in the contacts by the act of closing the block. When a fuse blows, all that is necessary is to open the block, drop a piece of straight copper wire in place, and then close it again. The fuse block shown herewith, which is made by the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., is ironclad, being completely enclosed in an iron casing, excepting where the vent for the arc extends through the bottom.

A Portable Photometer.

A very simple portable photometer has been brought out by Messrs. Everett & Edgcumbe. This consists of a small box containing a photometric screen, a tape attached and two lamp sockets connected to a suitable length of lamp cord, together with a plug for attaching to a lighting circuit. The instrument must be used in a dark room. The following is the method of use: A standard lamp, which is furnished with the photometer, is placed in one of the holders and then set upon the tape, as shown at *b* in the illustration. Another lamp, *c*, is then placed in the second holder, and moved backward and forward at either side of the photometer box until a balance is obtained. Then *b* is removed from its holder, and the lamps to be tested are placed therein, *c* remaining undisturbed. By shifting the lamp under test backward and forward on the tape until a balance is secured in each



PORTABLE PHOTOMETER.

case, the candle-power may be read off directly. Since both lamps are connected to the same circuit, variations in potential will have no effect upon the readings. As the standard lamp is used for but a brief setting, it should remain constant for a long time.

Office Cleats and Telephone Specialties.

James S. Barron & Company, New York city, are placing on the market a number of specialties for interior wiring

FIG. 1.—DOUBLE-GROOVED CLEAT.

which is meeting with a very popular reception. The accompanying illustrations show several types of these office cleats,

FIG. 2. PORCELAIN SINGLE-GROOVED CLEAT.

which this company is now supplying to the trade.

Fig. 1 shows a small, double-grooved cleat. This is for twisted pairs of conductors, and is made of composition, hard rubber or hard red fibre. The grooves are one-eighth inch by one-eighth inch. Fig. 2 shows a porcelain single-grooved cleat which is made for use with an accompanying backing. These are for twisted pairs of conductors, the grooves being seven-thirty-seconds by seven-thirty-

FIG. 3.—FANCY SINGLE-GROOVED CLEAT FOR TWISTED CONDUCTORS.

seconds of an inch. Fig. 3 is a fancy single-grooved cleat for twisted pairs of conductors, and is made in maple, with the grooves three-sixteenths by one-quarter of an inch, and one-quarter by nine-thirty-seconds of an inch.

Three Popular Forms of Telephone Apparatus.

The accompanying illustrations show three forms of telephone apparatus which are being used to a considerable extent throughout the independent telephone field. In Fig. 1 is shown a bridging telephone which is fitted with six-bar magneto, laminated armature and 1,600, 2,000 or 2,500-ohm ringer coils. The solid-back Bell style transmitter and bipolar receiver are used, and the instrument is supplied with three carbon batteries. This apparatus is for heavily loaded country lines where there are

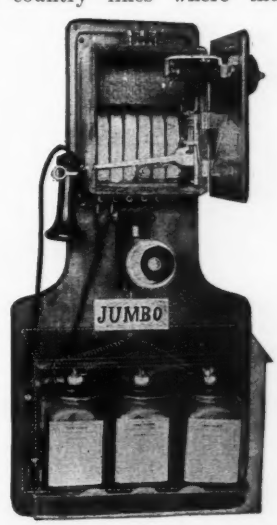


FIG. 1.—BRIDGING TELEPHONE WITH SIX-BAR MAGNETO.

thirty or forty telephones in multiple on the line. These telephones are supplied with generators which enable them to ring from one end of the line to the other with ease.

Fig. 2 shows a bridging telephone which is equipped with five-bar magnets, laminated armatures, 1,000, 1,600 or 2,000-ohm ringer coils. These telephones are used for every variety of service, both for exchange use and for country bridg-

ing lines. They are usually supplied with a 50,000-ohm or 100,000-ohm generator,

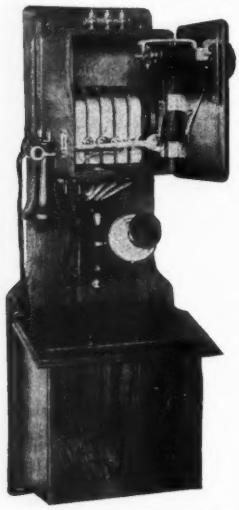


FIG. 2.—FIVE-BAR MAGNETO BRIDGING TELEPHONE.

using the solid-back transmitter, bipolar receiver and two carbon batteries.

Fig. 3 is a favorite in many exchanges, and is in wide use for residence telephones, being neat, compact and provided with dry batteries.

Magneto bells on these telephones are made from the best Norway steel, the armatures being laminated and wound with No. 33 silk-covered magnet wire. The automatic hook and switch are self-contained, made from phosphor-bronze spring metal with platinum tipped contacts. The receivers, of double-pole im-

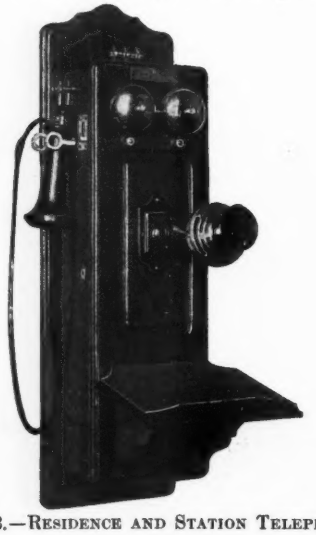


FIG. 3.—RESIDENCE AND STATION TELEPHONE.

proved design, are in four pieces when taken apart. No metal parts are exposed, as cords with tips are fastened direct to binding-posts between the magnets. A heavy stamped metal cup supports the magnets and ensures permanent adjustment. The metal cup and pole-piece are ground accurately to ensure proper adjustment.

These instruments are manufactured by the Farr Telephone and Construction Supply Company, 120 West Jackson Boulevard, Chicago, Ill.

Auxiliary Oscillating Base and Oscillating Fan.

The oscillating fan, the function of which is to throw the breeze to different sections of a room, has become very popular with fan users. One of the most recent applications of this idea to fan motors is illustrated in the accompanying engravings. This is designated as the "Comfort" auxiliary oscillating base, and is made by the Shedd Electric and Manufacturing Company, 50 Leonard street, New York city, the manufacturer of the well-known oscillating electric fan. Fig. 1 shows the oscillating base, Fig. 2 showing the base with a fan placed thereon. The current of air, impinging upon the blade as shown, causes the base to swing in a predetermined arc, the radius of which is determined by the set screws, which may be plainly seen in the illustration. It is claimed that by means of this appara-

FIG. 1.—THE NEW OSCILLATING BASE.

tus the fan, supplied with either direct or alternating current, is thrown from side to side without jar or vibration, it being unnecessary to fasten the fan to the base to keep it from creeping or losing its position.

Fig. 3 shows the oscillating electric fan, in which improvements have been made over the design of the preceding season. The flexible cord connecting the base and body of the motor has been discarded. This has been replaced by a spindle in the base, carrying collector rings having brush contact. In this season's fan the weight of the guard and fan blade upon the ball-bearing is perfectly balanced. In the prior forms of this fan, the operation required that the fan be placed almost level in order to oscillate it satisfactorily. With the new arrangement the model can be tilted to a considerable degree and work perfectly.

The deflecting blades in front of the fan blades have been reduced from three to one. With the elimination of the other two blades the conse-

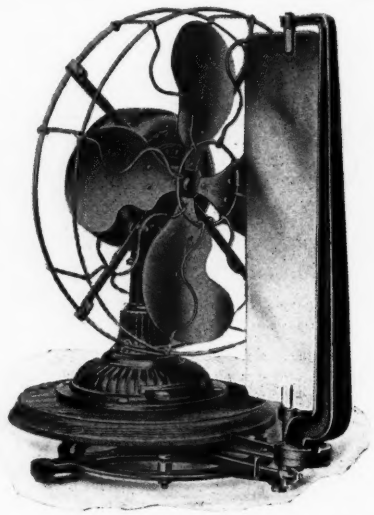


FIG. 2.—FAN MOTOR MOUNTED ON OSCILLATING BASE.

quent friction points have been removed. This ensures freer oscillation and presents less interference to the force of the breeze thrown out by the fan blade. The new form is more silent in running, the decrease in the number of deflecting blades cutting down the whir, and the more perfect balance also affecting the

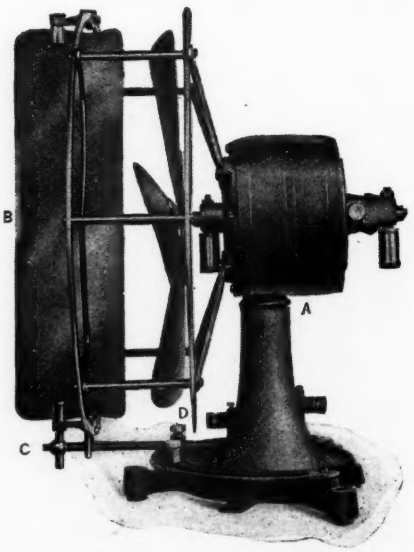


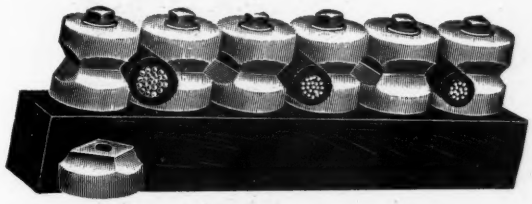
FIG. 3.—NEW OSCILLATING FAN MOTOR AND DEFLECTOR.

vibration noises. The adjustment screws upon the oscillating portion of the fan have been eliminated, and the connections made as simple and free from complication as possible. The standard finish throughout is solid brass, highly polished and lacquered. Nickel and oxidized copper finish is also supplied on special orders.

New Porcelain Insulators.

In the accompanying illustration is shown an adjustable porcelain cable insulator which has been patented and placed on the market by H. D. Murdock, of Station D, Pittsburg, Pa.

This insulator is made of two pieces exactly alike—the engaging grooves are arranged so as to form a parallelogram on the face of each half of the insulator—



ADJUSTABLE PORCELAIN CABLE INSULATOR.

the opposite grooves are of equal size and are corrugated to give a good grip to the cable—by combining these grooves in various ways, as shown, all sizes of cables from 300,000 to 1,000,000 circular mils can be securely clamped and held in position.

A smaller insulator made on the same lines will hold from No. 00 to 300,000 circular mils cable—thus covering the entire field from No. 00 to 1,000,000 circular mils with two sizes of insulators.

This is one of the strongest all-porcelain insulators on the market; strength, simplicity and adjustability have been so combined as to make an insulator of great practical value—20,000 were used in 1901 and 60,000 in 1902.

The Silvey Storage Battery.

This battery is the invention of W. L. Silvey, and is the result of a considerable

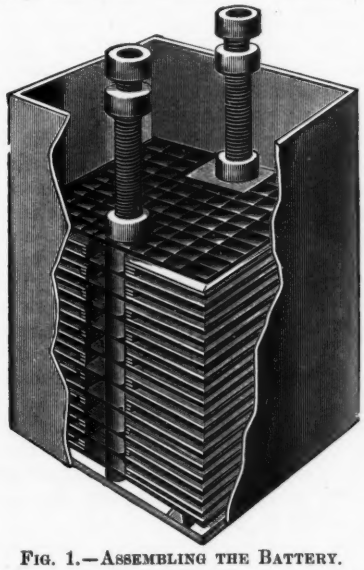


FIG. 1.—ASSEMBLING THE BATTERY.

period of practical research. The accompanying illustrations show the Silvey portable storage battery for car lighting, Fig. 1 showing the battery in its hard-rubber cell, Fig. 2 the battery plate, Fig. 3 the separator, and Fig. 4 the posts, nuts and connections for the portable cell. This cell is constructed in a substantial manner, designed to meet the needs of those who require a cell which will be subject to rough handling. The plates are perforated, the perforations being filled with material especially designed to admit of excessive discharge rates, the filling for the plates being superficially oxidized particles of metallic lead and an oxide of lead, hardened in place by chemical means, and then formed in a solution of sulphuric acid and water. After being made, the plates are bolted together, as shown in Fig. 1, a nut being placed between each plate; and to ensure perfect contact, the nuts and plates are electrically welded together.

The positive and negative plates are placed alternately, with a double thickness sheet of porous separating material between the plates. This separating material absorbs and carries about seven-eighths of all the solution, so that in case a battery jar gets broken; only a small percentage of the solution will be lost. The separator used is durable and serves a double purpose—retaining the solution and keeping the plates properly separated. The filling can not fall out of the holes in the conductor plate, and therefore the danger of short-circuit is necessarily lessened. These portable storage cells are made in all sizes up to 500 ampere-hours capacity.

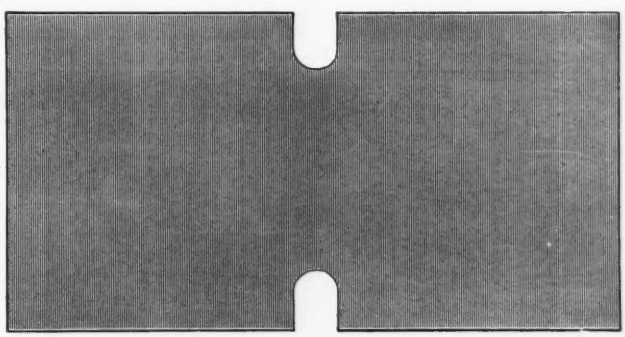


FIG. 2.—BATTERY PLATE.

FIG. 3.—THE SEPARATOR.

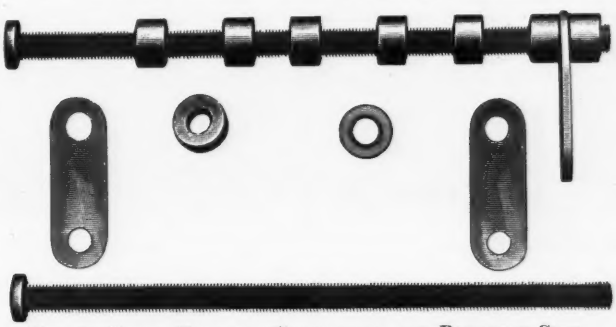


FIG. 4.—POSTS, NUTS AND CONNECTIONS FOR PORTABLE CELL.

The manufacturer of these cells also makes all sizes of central station cells. These cells have a capacity ranging from 500 to 20,000 ampere-hours, according to the number of plates used.

This storage battery is made by the Dayton Manufacturing Company, Dayton, Ohio.

A New Water-Wheel Installation.

The accompanying illustrations show the Plainwell power plant of the Kalamazoo Valley Electric Company, of Kalamazoo, Mich. Fig. 1 shows an exterior view of the dam and power plant, situated one and one-half miles below the village of Plainwell, Allegan County, Mich., on the Kalamazoo River. The dam has a total length of 1,200 feet. Of this, 850 feet is an earth embankment with concrete core wall, and 350 feet is composed of the flume and waste gates and a section of the concrete dam. The maximum head developed here is fourteen feet.

The plant covers an area of 125 acres. There are fourteen slide gates and one twenty-foot Taintor gate for handling surplus water at the time of flood. The dam is built entirely upon a pile foundation, with rows of sheet piling to form the offset, the soil being loose gravel. The flume section has concrete end walls, with a laminæ wood front wall, and stands at right angles to the bank, discharging the water directly down stream into the old river channel. Notwithstanding this design, it forms part of the dam.

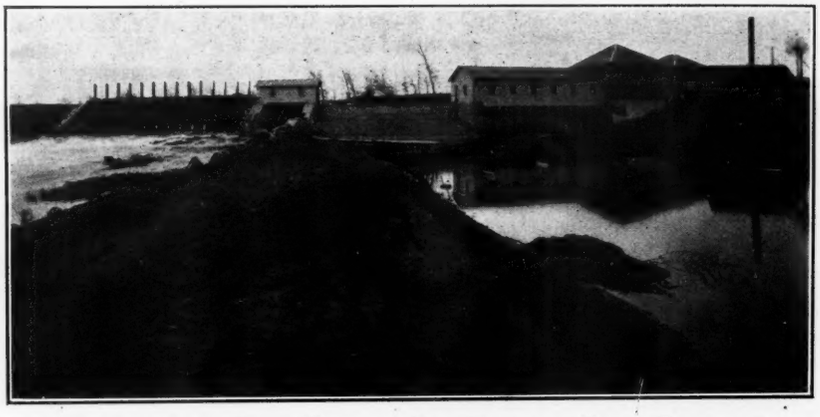


FIG. 1.—EXTERIOR VIEW OF POWER-HOUSE AND DAM, KALAMAZOO VALLEY ELECTRIC COMPANY.

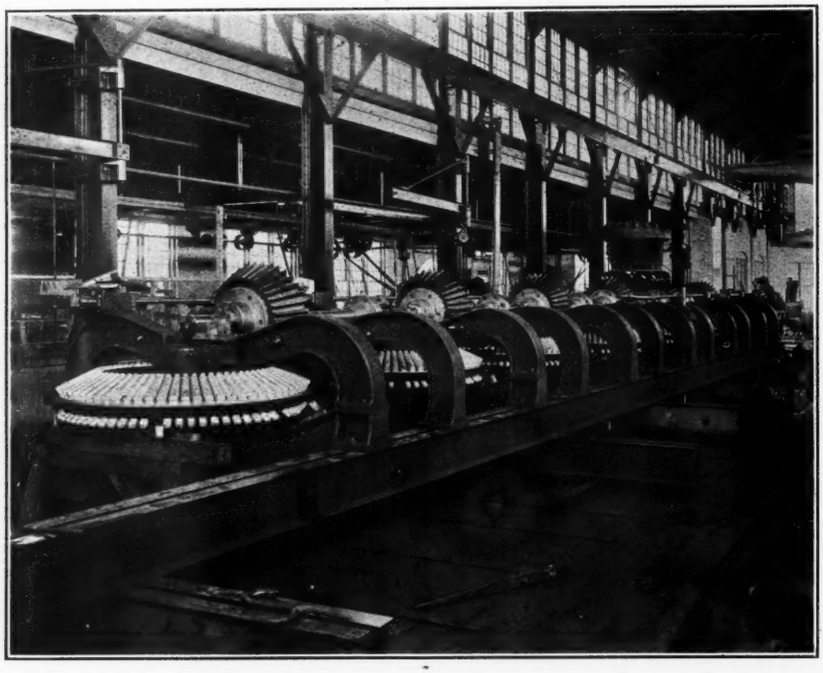


FIG. 2.—PLAINWELL POWER PLANT OF THE KALAMAZOO VALLEY ELECTRIC COMPANY.

There are six fifty-inch Leffel Samson wheels, geared to a main line shaft extending across the top. This is shown very clearly in Fig. 2, this view being made on the floor of the James Leffel & Company's factory at Springfield, Ohio. This shaft projects into the generator room, which is located on the west bank of the river, and is connected to a 1,000-kilowatt, three-phase alternator. The generator house is a brick building with a slate roof. The current from this generator is led to a transformer house, built of brick with slate roof, located about fifty feet distant, where it is stepped up from 2,300 volts to 25,000 volts, and at this pressure it goes into the transmission line of the Kalamazoo Valley Electric Company, which runs from its plant located in Trowbridge township, ten miles below, to Battle Creek, a distance of forty-five miles.

The Invasion of the American Steam Turbine.

Westinghouse steam turbines of various sizes are being rapidly introduced in American industrial, power and lighting works. The steam turbine machinery manufactured by the Westinghouse Machine Company is applicable to many classes of electrical power service, comprising electric railway central stations, lighting and power; isolated plant power, combined railway and lighting, industrial plant power, etc. The turbo-generator units are specially adapted for parallel operation and have demonstrated this feature of excellence in many installations now in operation. Although upon the market less than four years, there is already in successful operation 4,000 kilowatts of turbine machinery and 75,000 kilowatts have been contracted for. A new turbine building shop has recently been put into service by the Westinghouse Machine Company, which has largely increased its manufacturing facilities in this new field of work. Particulars concerning a few of the more recent turbine installations may be of interest.

Two American railway installations are those of the Cleveland, Elyria & Western Railway Company and the Consolidated Railways and Lighting Company, of Wilmington, N. C., each of which will generate alternating-current power at a central station, employing transmission lines and rotary converter substations along the right of way.

The steam turbine equipment of the Hartford Electric Light Company, Hartford, Ct., is to be duplicated in the near future. The present Corliss engine equipment will be replaced by two 1,000-horsepower turbines, direct-connected to revolving field polyphase generators. These units will operate in parallel with the 1,500-kilowatt unit installed one year ago and were chosen for the purpose of securing the utmost flexibility and economy in the operation of the plant. The turbine plant will operate upon superheated steam, with 150 pounds pressure and a high vacuum. The original installation created much interest among engineers and power users.

The Westinghouse steam turbine is controlled by Westinghouse, Church, Kerr & Company, New York, Boston, Chicago, Pittsburg, Detroit and Philadelphia.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

POSTAL WIRES ON THE UNION PACIFIC—The Union Pacific Railroad Company and the Postal Telegraph Company have come to an agreement by which the Postal company will build a line of wires on the Union Pacific right of way, from Omaha to the Pacific coast. The line will carry six wires, and the total cost of construction will be $1,500,000. The object of the new line is to connect the Postal company's system more directly with the Pacific cable now being constructed.

NEW JERSEY TRACTION LINES MAY MERGE—A plan is under way in New Jersey to effect the merging of a number of large trolley lines. The plans are to operate under one corporation 450 miles of the total trolley system. This company will probably be capitalized at $50,000,000, and will control all the street railroads with the exception of a few lines in southern New Jersey. The new company will be called the United New Jersey Railways Company, and one of the propositions is to effect an entrance into New York city through the projected tunnels of the Pennsylvania Railroad.

ANOTHER COLORADO POWER PROJECT—A corporation to be known as the Tarryall Water and Power Company has under advisement a plan to establish a $5,000,000 company to furnish light and power to cities, and water for irrigation purposes. Property has already been purchased, comprising 20,000 acres, on Tarryall, Michigan, Rock and Jefferson creeks, near Denver, Col. The promoters state that $4,600,000 will be expended in improvements and franchises in Denver, Colorado Springs, Cripple Creek, Leadville, Pueblo, Central City and Blackhawk. It is also announced that construction will begin in sixty days.

ARMY POST WIRELESS TESTS—An official trial of the practicability of the wireless telegraph for the uses of the United States Army Posts of the East has been held under the direction of Lieutenant-Colonel H. H. C. Dunwoodie, chief officer of the Signal Service Corps, Department of the East. Communication by the De Forest system has been established between the military telegraph stations of Fort Wadsworth, Staten Island, and the new station at Fort Hancock, on Sandy Hook. The distance between the posts averages about eighteen miles. These tests are to continue for about a month, with the regular telegraphers of the service doing the work. Preliminary tests have so far proved satisfactory.

EXTENSIVE THIRD-RAIL SYSTEM—The Albany & Hudson Railroad Company has been incorporated with a capital of $27,000,000. The company has acquired the property and franchises of the Albany & Hudson Railway and Power Company, which operates the third-rail electric line from this city to Hudson. The officers are: C. L. Rossiter, president; A. M. Young, first vice-president; George G. Blakeslee, second vice-president and general manager; L. B. Grant, secretary; H. G. Runkle, treasurer. The directors are: H. G. Runkle, C. L. Rossiter, A. M. Young, Foster M. Vorhees, William F. Sheehan, R. A. Smith, and C. L. Seibert, of New York, Horace Andrews, of Cleveland, Ohio, and Seth L. Keen, of Brooklyn.

PORTO RICO POWER PLANT—A franchise has been obtained by a Philadelphia company to construct and operate an electric railway and supply light and power in Porto Rico. Three million dollars, it is stated, will be required to construct and equip the works. A railroad line eighty miles long is proposed, to extend from San Juan to the valley of the Rio Lorze, and thence through Caguas and Cayey, from Caguas to Coamo, a distance of eighteen miles. The line will be built with heavy grading, and the Cordillera will be crossed between these points with a maximum ascending and descending grade of four per cent and a summit tunnel 1,100 feet long. The road-bed will be standard gauge, with seventy-five-pound T-rails. The overhead construction will consist of standard flexible brackets, except where the centres of streets in the towns along the line are occupied, and at these places span construction will be employed. Water power will be utilized at two points in the interior of the island to generate electricity for railway, industrial and lighting power. The power plant at Comerio Falls, on the Rio de la Plate, will develop about 3,000 horse-power.

THE FIRST SPIKE DRIVEN FOR THE TRACK SYSTEM IN THE NEW YORK SUBWAY—On Saturday afternoon, March 14, Mayor Low drove the first spike for the tracks of the rapid transit subway in New York city. The ceremony took place in the presence of a distinguished party of the municipal government of New York city, at Sixtieth street and Broadway. The underground station at that point is nearly completed, and that section of the subway is in an advanced state of construction. Nearly all of the city's departments were attendants at the ceremony, the following gentlemen being present: Corporation Counsel Rives and J. C. Clarke, from the law department; Borough President Cantor and Secretary George Blake; Fire Commissioner Sturgis and William O'Leary, from the fire department; President Fornes and Vice-Chairman McInnes, of the board of aldermen; Captain Gibson, from the street cleaning department; Commissioner Lederle, from the department of health, and Messrs. Garvan and Studin, from the district attorney's office. Mr. William Barclay Parsons, the engineer who mapped out the subway plans, was complimented on the great progress which was being made in the work, as was also the rapid transit commissioners.

PORTCHESTER ROAD WINS—The Appellate Division of the Supreme Court, Third Department, State of New York, has rendered a decision sustaining the State Board of Railroad Commissioners in authorizing the New York & Portchester Railroad Company to construct an electric street railroad line from Harlem to Portchester, through Mount Vernon and New Rochelle. The appellants in the case were the New York, New Haven & Hartford Railroad Company and the New York City & Westchester Railroad Company. The opinion was written by Presiding Justice Parker. The road, completed and equipped, is expected to cost between $12,500,000 and $13,000,000. It is to be a four-track line, extending from Mount Vernon to Portchester, a distance of about twenty-five miles, and passing through New Rochelle, Pelham, Larchmont, Mamaroneck, Harrison and Rye. Besides this line there will be a subway about two and one-half miles in length from the southeast corner of Bronx Park to the East River, giving service for Van Nest, Westchester and other localities in that part of the Borough of the Bronx. Eight miles of the road will be in New York city. The line will be constructed along private right of way owned by the company, and there will be no crossings at any point.

PLANS FOR THE SOUTH AFRICAN POWER PLANT AT JOHANNESBURG—The construction of the proposed electric traction, lighting and general power system in the city of Johannesburg is estimated at nearly $8,000,000 by Moodey & Dawbarn, the London engineering experts, whose plans have been accepted by the municipal authorities of that city. The electric road will be twenty-seven and two-third miles long. The existing line is run by horse-power, eight and one-half miles long, and owned by the Johannesburg City & Suburban Tramways Company. The electric light and power-generating stations initial equipment has a capacity of 9,000 horse-power. Three 2,000-horse-power gas engines, direct-connected to the same number of 1,250-kilowatt dynamos, will be purchased. Three 1,000-horse-power gas engines, coupled to alternators of 675 kilowatts capacity each, with exciters, will also be installed. For the installing of switchboards, motor balances and electrical engine room accessories, £13,630 is to be allotted. Producer gas generators for 6,075 kilowatts are expected to mean the expenditure of £25,200. Cooling towers, pipe work and electrical connection inside station are calculated to cost £18,475. For coal and ash conveyors, bunkers, engine room, traveling crane, tools and accessories, £12,060 will be put aside. For the buildings, which will be planned so as to permit of the ulti-

mate installation of two additional engines and dynamos of 2,000 horse-power capacity each, £74,520 will be allotted. The purchase and laying of the inner and outer area cables, together with the underground street lighting cables for the inner area, arc lamps, etc., it is estimated, will entail an expenditure of £485,880. For the equipment of the generating station to operate the electric traction system, £65,959 will be allotted. There is to be one 2,000-horse-power gas engine and a dynamo of one 1,000-horse-power set. The initial number of cars will be seventy-five.

EXTENSIVE ELECTRIC RAILWAY CHANGES FOR BROOKLYN—Chief Engineer Parsons has submitted the following plan for the reorganization of the Manhattan-Brooklyn electric railway service. The plan contemplates the removal of all elevated trains from the old Brooklyn Bridge, trolleys only to be operated on the present elevated tracks, and the roadways restored exclusively to vehicles; a second East River tunnel from Nassau and Orange streets, Brooklyn, to Maiden Lane, Manhattan, to handle the elevated traffic by means of connection with the Manhattan and Williamsburgh bridges. This plan involves a new subway in Manhattan, from Maiden Lane to the Williamsburgh bridge, connecting with the old bridge and the Manhattan bridge; a temporary arrangement for handling traffic at the Manhattan end of the Williamsburgh bridge, pending the completion of the Centre street subway; a four-track subway from Flatbush and Atlantic avenues to the Prospect Park Plaza, with a loop at that point to a three-track subway, continuing along Eastern Parkway to East New York avenue; also a continuation along Flatbush avenue to East Broadway by means of a two-track subway; a combination subway and elevated from Flatbush and Atlantic avenues along Fourth avenue to Fort Hamilton, with a tunnel connection from Atlantic avenue, Brooklyn, to Whitehall street, Manhattan; additional tracks on the present elevated lines for the handling of express trains by the Brooklyn Rapid Transit Company, as follows: One extra track on Fulton street, two on Broadway and one on Myrtle avenue and one on Fifth avenue; an "L" road connection between the Fulton street line and the Jamaica Plank Road, and a connection between the Fulton and Fifth avenue lines in the shopping district; a new elevated road from Franklin avenue and Fulton street along Franklin avenue to Wallabout street, to Gwinnett street, to Lorimer street, to Manhattan avenue, connecting Vernon and Jackson avenues, in Long Island City, to the Blackwell's Island bridge; a spur from this line from Lorimer street to the Williamsburgh bridge; other suburban extensions of the Brooklyn Rapid Transit elevated system, and the removal of grade crossings on the Brighton Beach line.

OBITUARY NOTICES.

MR. L. A. DAMON, one of the department superintendents of the Westinghouse Electric and Manufacturing Company at East Pittsburg, died on Monday, March 2. Mr. Damon was thirty-three years of age and resided at East Pittsburg.

MR. EVERTON BURRITT ARNOLD died in Lock Haven, Pa., on March 9. He had been ill for about ten days with typhoid-pneumonia. Mr. Arnold was born in Ashland, Neb., and was educated in the public schools of that place, and at Hillsdale College at Hillsdale, Mich. He was in charge of the factory of the Pumpelly & Sorley Storage Battery Company, of Chicago, from 1893 to 1895. Since 1895, he had been connected with the Arnold Electric Power Station Company, of Chicago, Ill., in a confidential capacity, in charge of material and finances on construction work. Mr. Arnold was a member of a family which has occupied the electrical field with more or less prominence for some time. He is survived by his mother and five brothers—Bion J., Wayland L. and Ralph G., of the Arnold Electric Power Station Company; Ward S., of the Chicago office of the Stanley Electric Manufacturing Company, and Harold W., of the Western Electric Company. His one sister is Mrs. Gould, wife of D. C. Gould, of the Stromberg-Carlson Telephone Manufacturing Company. At the time of his death, Mr. Arnold was thirty-one years of age, and was just fininshing up his work, superintending the construction of the Oak Grove shops of the New York Central Railroad at Oak Grove, Pa., when he was taken ill. He was removed to Lock Haven where he died. The funeral services were held at the residence of Mr. Bion J. Arnold, and the interment was made at Ashland, Neb.

PERSONAL MENTION.

MR. GUY W. BUXTON, who has for some time been connected with the New York office of the H. W. Johns-Manville Company, has been recently appointed auditor of that company.

DOCTOR FRANK A. WOLFF, of the National Bureau of Standards, Washington, D. C., will lecture on "Modern Methods of Electrical Standardizing," before the Franklin Institute, of Philadelphia, Pa., on March 26.

DOCTOR HARRY C. JONES, associate professor of physical chemistry of Johns Hopkins University, Baltimore, lectured on March 19 before the Franklin Institute, Philadelphia, Pa., on "What Physical Chemistry has done for Chemistry."

MR. H. T. HARTMAN, Philadelphia, Pa., has been requested by President Ferguson to take charge of the question box for the twenty-sixth convention of the National Electric Light Association, to be held in Chicago, May 26, 27 and 28. This he has consented to do. It is hoped that at this session the question box will become a very prominent feature of the programme.

MR. GEORGE H. DAVIS, general manager of the Birmingham Railway, Light and Power Company, it is announced, has resigned on account of ill health. It is also announced that Mr. David A. Belden, vice-president and general manager of the Georgia Railway and Electric Company, of Atlanta, Ga., has resigned his position, and has accepted the position made vacant by Mr. Davis.

MR. JOHN DAVIDSON has associated himself with the Sterling Electrical Manufacturing Company, of Warren, Ohio, manufacturer of the well-known Sterling Special incandescent lamps, making his headquarters at the New York office of this company, 26 Cortlandt street. Mr. Davidson has for some time been connected with the Germania Electrical Lamp Company of New Jersey.

CHARLES P. STEINMETZ, in the current issue of *Concordiensis* of Union College, presents an interesting sketch of the conditions of the new electrical course of that institution, of which he is director. The very favorable conditions which exist at Schenectady for affording the students opportunities to familiarize themselves with the practical work of their profession, is pointed out by Mr. Steinmetz, and this is one of the reasons which has led him to undertake the organization and direction of the electrical engineering course at this institution.

PROFESSOR WILLIAM ESTY, of Lehigh University, was retained recently by the town council to investigate the conditions of the electric lighting in that city. Measurements were made at the lighting station of the current supply, voltage across the lamps, and of the quality of the carbon used. The carbons were found to be as good as can reasonably be expected in open arc service. The current supply, however, was found to be somewhat less than normal, being only 8.47 amperes, instead of 9.6. Voltage measurements on such lamps as were available also showed a value below the normal. The question in dispute was whether the lamps furnished to the borough were "2,000 candle-power," and assuming this to mean a lamp consuming 450 watts, the above figures show that the light given was considerably less than it should have been.

MR. CLOYD MARSHALL has recently been appointed superintendent of electrical machinery in the department of electricity of the Louisiana Purchase Exposition, and has actively taken up his new duties. The electrical and engineering training which Mr. Marshall has received has well-fitted him for the work he has now undertaken. After graduating from the school of electrical engineering of Purdue University in 1895, he was retained as assistant in the electrical laboratory. Later he accepted the position of electrical editor of the *Street Railway Review*, of Cnicago, and during the period of this connection, from 1896 to 1898, he served as secretary of the Chicago Electrical Association. Mr. Marshall for two years held the position of designing and testing engineer for the Jenney Electric Manufacturing Company, and then took up experimental work for the Railway Materials Company, of Chicago. In 1901 he accepted the position of plant engineer, and, later, of engineer of the sales department of the C. W. Hunt Company, of West New Brighton, S. I. The latter position he has just resigned in accepting the appointment of the World's Fair directors. The record Mr. Marshall has made as a progressive engineer and business man argue well for the success of the department of the great exposition with which he is connected.

ELECTRICAL SECURITIES.

The very poor showing made by the bank statement of a week before last was followed by a slightly panicky condition in the financial districts and a very large proportion of shares manipulated was sold at declining figures. The week on the whole, however, showed less losses than was anticipated and the most recent bank statement is less disappointing than expected. Call money for the week ruled from an average of five per cent to a high point at eight per cent.

Apart from the money conditions, the fluctuations in the market were of more or less speculative nature; the upward trend of prices beginning in the middle of the week showing that strong hands were still in possession of the favorite securities. Provided crops do not prove a disappointment, which owing to the advanced condition of the season seems practically settled, the current year will be especially prolific in good returns. While the prospect of the usual spring boom having any immediate impetus is poor, there is sufficient buoyancy apparent to forestall any serious apprehension in this direction.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 14.

New York:	*Closing.*
Brooklyn Rapid Transit	65¼
Consolidated Gas	205½
General Electric	193½
Kings County Electric	225
Manhattan Elevated	140¾
Metropolitan Street Railway	133¼
New York & New Jersey Telephone	166
Westinghouse Manufacturing Company	211

The directors of the General Electric Company have declared the regular 2 per cent quarterly dividend, payable April 18, to stock of record March 21.

The directors of the Westinghouse Electric and Manufacturing Company have declared the regular quarterly dividend of 1¾ per cent on the preferred stock, payable April 1. Books will close March 18 and reopen April 2.

Boston:	*Closing.*
American Telephone and Telegraph	165½
Edison Electric Illuminating	290
Massachusetts Electric	91⅞
New England Telephone	138
Western Telephone & Telegraph preferred	99

Philadelphia:	*Closing.*
Electric Company of America	8 15/16
Electric Storage Battery common	80
Electric Storage Battery preferred	79
Philadelphia Electric	6⅝
Union Traction	46¾
United Gas Improvement	107

The directors of the United Gas Improvement Company have declared a quarterly dividend of 2 per cent payable April 15, 1903, to stockholders of record at the close of business March 31, 1903.

The directors of the Electric Storage Battery Company have declared the regular quarterly dividends of 1¼ per cent on the common and 1¼ per cent on the preferred stock, payable April 1. Books close March 26 and reopen April 1.

Chicago:	*Closing.*
Chicago Telephone	155
Chicago Edison Light	156
Metropolitan Elevated preferred	81
National Carbon common	24½
National Carbon preferred	97¾
Union Traction	9½
Union Traction preferred	42

The directors of the Chicago Telephone Company have reelected the old officials and declared the regular quarterly dividend of 2½ per cent payable March 31 to stockholders of record March 25. Books close March 25 and reopen April 1.

LEGAL NOTE.

DECISION IN THE TESLA-FERRARIS CONTENTION—Justice Colt, in the Supreme Court of the United States, District of Massachusetts, handed down on March 11, 1903, a decision in favor of the Stanley Instrument Company, defendant, in the case brought by the Westinghouse Electrical and Manufacturing Company for infringement of the Tesla patents as applied to the meters manufactured by the Stanley company. The opinion of Judge Colt is as follows: "Upon careful consideration of the evidence, I have reached the conclusion that the complainant has failed to establish by sufficient proofs the conception by Tesla of the inventions in suit prior to April 22, 1888, the date of the Ferraris publication. In complainant's supplemental brief I find no reason stated or authority cited which should lead the Court to any different conclusion."

NEW INCORPORATIONS.

DES MOINES, IOWA—Sutherland Telephone Company. $4,500. Incorporators: E. W. Parker, D. M. Sheldon and others.

GREENFIELD, IND.—The Blue River Telephone Company. $12,000. Directors: Oliver Binford, Omar Binford and E. Clarkson Elliott.

HAYWARD, WIS.—Hayward Electric Light and Power Company. $25,000. Incorporators: T. S. Whitton, J. H. Hellweg and Henry Murphy.

NEW YORK, N. Y.—The Rosement Electric Transmitter Company. $250,000. Directors: Herman Schwarz, Julius Rosenberger and A. H. Schwarz.

CATSKILL, N. Y.—West Shore Home Telephone Company. $100,000. Directors: S. B. Rawson and T. M. Brush, of Elyria, Ohio, and Howard Hendrickson, of Albany.

JERSEY CITY, N. J.—Puget Sound Electric Railway. $3,000. Incorporators: Preston Player, Nathan H. Daniels, Jr., Howard L. Rogers, Henry Reed Hayes, George C. England, Waldo E. Forbes, Alvah K. Todd and Gardner Rogers, of Boston, and Louis B. Dailey, of Jersey City.

INDIANAPOLIS, IND.—The Crawfordsville Cooperative Telephone Company. $10,000. Incorporators: M. E. Clodfeller, C. R. Beck, J. I. Miller, Clinton Snyder, W. H. Nicholson, Charles L. Harris, Clarence Williams, W. L. Sinnet, George N. Bowers, Clyde H. Jones and others.

TELEPHONE AND TELEGRAPH.

DES MOINES, IOWA—The Latimer Telephone Company has been granted a franchise at Thornton.

SIOUX CITY, IOWA—T. A. Thompson and William Milchrist have asked for a telephone franchise in this city.

MELLEN, WIS.—The Wisconsin Telephone Company is building a long-distance telephone and telegraph line from Ashland to Mellen.

FARGO, N. D.—It is stated that a telephone line is contemplated between Tower City and Page, and that the Valley City Telephone Company is arranging for an extension to Litchville.

OMAHA, NEB.—The stockholders of the Nebraska Telephone Company at their annual meeting reelected the board of directors and all officers, except J. J. Dickey, deceased, who was succeeded as vice-president by C. W. Lyman, of Omaha. The capital stock was increased by $1,000,000, which will be used in extensions and betterments.

TROY, N. Y.—The Hudson River Telephone Company has elected the following officers: President, James H. Manning; vice-president, Jeffries Wyman; secretary and auditor, Walter B. Butler; treasurer, James J. Fitzsimmons; general manager, Henry E. Hawley. The company's report shows a gratifying increase in business for the year recently closed.

BINGHAMTON, N. Y.—At a meeting of the local telephone lines, held at Chenango Forks recently, arrangements were made for the consolidation of several companies under the title of the Chenango Valley Telephone Company. The lines consolidated are as follows: Castle Creek & Whitney's Point, Chenango Bridge & Castle Creek, Chenango Bridge & Chenango Forks, Chenango Bridge & Port Crane, Port Crane & Sanitaria Springs. A line is soon to be built from the Forks to Greene, and it is expected that this will be merged with the others.

YORK, PA.—The charter of the York Eastern Telephone Company has been recorded, with the following directors: A. M. Grove, M. H. McCall, Henry S. Merryman, John H. Wilson, B. F. Norris, Joseph A. Gaily and Calvin M. Shaw. The authorized capital is $8,000. The charter states the purpose of the corporation to be erecting, constructing, purchasing, leasing and operating telephone and telegraph lines and exchanges in and through the county of York, with the right to make connections with similar lines in other counties of this state.

INDUSTRIAL ITEMS.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., has recently sold to the Watertown Electric Company, Watertown, Mich., a new street lighting equipment, consisting of two fifty-light series alternating circuits.

THE MARSHALL-SANDERS COMPANY, 301 Congress street, Boston, Mass., is making a specialty of its No. 521 plug and receptacle at this season of the year, and states it is in great demand during the fan motor season. This plug is one inch in diameter, and has other features of interest.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., has lately increased its warehouse room, and consequently its carrying capacity for all kinds of wires, for which it is the agent. The assortment is complete in "O. K." weatherproof line and house wires, "Paranite" and "Peerless" rubber-covered wire, Roebling's galvanized iron telephone and telegraph wire, etc.

THE LYON METALLIC MANUFACTURING COMPANY, 137 and 139 Fulton street, Chicago, Ill., has placed on the market a new form of the Lyon oily waste can. This is provided with a self-closing cover and is entirely of lapped-joint construction throughout, no solder being used. The stock sizes of these cans are 12, 14, and 15 inches in diameter, being 12, 16 and 23 inches high, respectively.

THE SPRAGUE ELECTRIC COMPANY, 527 West Thirty-fourth street, New York city, in catalogue No. 410, illustrates and describes iron armored, brass armored, unarmored and flexible metallic interior conduit. Armored cables, conduit fittings, boxes, elbows and couplings, and special tools and supplies are also included. This catalogue is very complete, is carefully indexed, and the engravings and descriptions are easily followed.

THE PROMETHEUS ELECTRIC COMPANY, 60 Reade street, New York city, manufactures a wireless electric heating system for electric heating and cooking apparatus and resistances. The heater consists of a strip of mica, upon which a layer of metal has been deposited, or, more properly speaking, fired. This conducting strip is protected by another piece of mica, and the whole is enclosed in a metal casing. This unit or heating element can be painted to any desired resistance.

THE GORDON BATTERY COMPANY, New York city, manufacturer of the Gordon cell, has just issued a new catalogue descriptive of this apparatus. This cell is guaranteed by the company to have a high electromotive force, low internal resistance, with a great length of life. In addition to these features of value, the connections are non-corrodible. The current supply is uniform, and there is an absence of odors, and cleanliness, with invariability of action in changing temperatures.

THE AMERICAN CONDUIT COMPANY, with offices at Philadelphia, Chicago and Los Angeles, has just issued an attractive catalogue describing its bituminized fibre conduit. This conduit is made of non-corrosive material, and is protected against moisture or other deteriorating action of the elements. The design of this conduit makes it unnecessary to wrap the joints with burlap or other material. The ends are dipped into a pot of compound and the ends properly sealed as the work of construction proceeds.

THE OTIS ELEVATOR COMPANY, New York city, has been awarded the John Scott Legacy Medal and Premium by the Franklin Institute for its electric elevator for private residences, which dispenses with the services of an attendant and is operated by pushing buttons at the various landings and in the car. The committee on science and the arts, which recommended the award, made a thorough inspection of several existing installations and its report is highly commendatory of the ingenuity of design, the safety of operation and the substantial construction of this elevator.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., describes and illustrates in pamphlet No. 031 some applications of "Industrial" railways to boiler rooms. In addition to the description of this apparatus, half-tone engravings illustrate this form of equipment at the Government Tramway Power Station, Sydney, New South Wales, Australia; the Standard Rule and Level Company, New Britain, Ct.; the Brooklyn Waterworks, Brooklyn, N. Y., and several other typical installations. The C. W. Hunt Company builds "Industrial" railway tracks, switches, turntables and many varieties of cars to suit any kind of service.

E. B. LATHAM & COMPANY, 39 Vesey street, New York city, have shipped several large orders of Tuerk alternating-current ceiling fans, for both export and domestic use. The design of the Tuerk fan this year remains practically the same as originally placed on the market. These fans are made with two and four blades, with and without electrolier attachment. Each fan is provided with a starting switch and an attachment for adjusting the angles of the blades while running. The blades have a sixty-inch spread and are eight inches wide. The speed on both high and low frequencies averages 175 revolutions per minute.

MR. JAMES G. BIDDLE has removed his offices from the Stephen Girard Building to rooms 60 and 62, 1114 Chestnut street, Philadelphia, where he will have better accommodations than heretofore for giving proper attention to his business in high-grade electrical measuring instruments. Full descriptive matter, giving details of the Hoopes conductivity bridge, a new device for accurately measuring conductivity and designed by Mr. William Hoopes, electrical engineer of the Pittsburg Reduction Company, will be sent on application. This device is being manufactured by Morris E. Leeds & Company, of Philadelphia, for whom James G. Biddle is sole agent.

THE L. B. ALLEN COMPANY, Chicago, Ill., manufacturer of the Allen soldering stick and other well-known specialties, is in receipt of the following letter: "I have used the Allen soldering stick on all kinds of electrical work and on many other classes of work, and can honestly say that I am more than pleased with the results, the main feature being its cleanliness. Although soldering paste is good, I will hold on to the Allen stick for many kinds of work." The Allen company states that there are several soldering sticks now being sold which are injurious to satisfactory connections, containing deleterious ingredients, and will be pleased to supply accurate information to electricians on request.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has secured a contract from the Consolidated Canal Company, of Mesa, Ariz., for an irrigating plant, consisting of the following apparatus: One 300-kilowatt, three-phase, revolving-field alternator, running at 400 revolutions per minute and 11,000 volts (this being direct-coupled to a water-wheel); three 50-horse-power, type "C" motors of 200 volts, 7,200 alternations, and 850 revolutions per minute. These will be used in operating irrigation pumps. All of this machinery has been shipped and is now being installed. The Bishop & Babcock Company, of Cleveland, Ohio, is equipping its machine shop for electric driving, adopting the group system. Short lengths of line shafting are driven by Westinghouse induction motors. Seven or eight of these, ranging in size from ten to forty horse-power, have been purchased, and are now in operation, the current being temporarily supplied from the plant of the Cleveland Twist Drill Company, which is also equipped with Westinghouse apparatus. The Bishop & Babcock Company is installing a power plant of its own, and has recently purchased a 175-kilowatt, two-phase, Westinghouse, engine-type alternator, with switchboard complete. G. S. Rider & Company is the engineer for the plant.

THE ALLIS-CHALMERS COMPANY announces that after March 20 the Salt Lake City branch office will be located at 209 and 211 Southwest Temple street. The Allis-Chalmers Company submits the following partial list of engine sales for February, 1903: Bucyrus Company, South Milwaukee, Wis., one 16 by 42, 1890 frame, Reynolds-Corliss engine; Southwestern Missouri Electric Railway Company, Webb City, Mo., one 30 and 60 by 48, horizontal, cross-compound, direct-connected, Reynolds-Corliss engine; Albert Schwill & Company, Chicago, Ill., two 26 by 48, 1890 frame, direct-connected, Reynolds-Corliss engines; Wausau Paper Company, Brokaw, Wis., one 16 by 36, girder frame, Reynolds-Corliss engine; Vulcan Iron Works, San Francisco, Cal., one 14 by 36, girder frame, Reynolds-Corliss engine; Union Electric Light and Power Company, St. Louis, Mo., one 12 by 16 engine; George M. Moulton & Company, Chicago, Ill., one 24 and 48 by 48, steeple compound, Reynolds-Corliss engine; Louisville Railway Company, Louisville, Ky., two 40 and 78 by 60, vertical, cross-compound, direct-connected, Reynolds-Corliss engines; Denison Light and Power Company, Denison, Tex., one 16 by 36, 1890 frame, Reynolds-Corliss engine; Albuquerque Gas, Electric Light and Power Company, Albuquerque, N. M., one 16 and 28 by 36, horizontal, cross-compound, direct-connected, Reynolds-Corliss engine; Denver Engineering Works, Col., two single, differential, electric motor driven Riedler pumps.